RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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GENERAL INFORMATION

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Introduction of the Carman Lecturer

THOMAS B. BOND, M.D.

MEMBERS OF THE Radiological Society of North America and Guests: We are assembled here tonight for the Carman Lecture, established in memory of Dr. Russell D. Carman, who died at the peak of his career while serving as Chief of the Department of Roentgenology at the Mayo Clinic. The first Carman Lecture was delivered by Dr. B. R. Kirklin in 1939 and it has been an annual event since. Tonight's lecture will be presented by Dr. Axel Norman Arneson.

Dr. Arneson was born in Fort Worth, Texas. He attended the public schools of that city and received his B.S. degree from Texas Christian University (which also has a football team). He received his M.D. from Washington University in St. Louis and was a Fellow at Memorial Hospital in New York for the next three years. He has the distinction of being a Diplomate of both the Board of Radiology and the Board of Obstetrics and Gynecology. We have first claim on him, however, because he became a Diplomate of the Board of Radiology in 1936 and did not become a Diplomate of the Board of Obstetrics and Gynecology until three years later. I believe that Dr. Arneson and Dr. Henry Schmitz are the only ones to have held this dual honor.

Dr. Arneson served as a Lieutenant Colonel in the Medical Corps of the United States Army in the last war. He is a member of the Radiological Society of North America, the American Gynecological Society, the American Association of Obstetricians and Gynecologists, the Central Association of Obstetricians and Gynecologists, and the Society of Pelvic Surgeons. He was President of the American Radium Society in 1947 and 1948 and represents that organization on the Board of Chancellors of the American College of Radiology. He was President of the St. Louis Gynecological Society in 1948 and 1949; President of the St. Louis Surgical Society in 1951 and 1952; President of the Alumni Association of the Washington University School of Medicine in 1952 and 1953; alumni representative to the Corporation of Washington University for 1953 to 1955; and President of the St. Louis Medical Society in 1953 and 1954.

He is now Professor in Clinical Obstetrics and Gynecology, Associate Professor in Clinical Radiology, and Attending Gynecologist of the Barnes Hospital Group, Washington University School of Medicine, St. Louis, Mo. He is also consultant in radiology for the Veterans Administration Cochran Hospital, St. Louis.

There are many things I could say about Dr. Arneson's family. His father established the first building and loan association in our part of the Southwest and this, incidentally, is now one of the largest such associations in that region. A plot of ground in a busy area on one of our principal thoroughfares, donated by the family, is known as Arneson Park. Dr. Arneson really belongs to Fort Worth and to Texas. We have very graciously loaned him to St. Louis.

A. N. Arneson, M.D.
Carman Lecturer

The Clinical Relationship of Radiology and Gynecology in the Treatment of Cervical Cancer

The Carman Lecture[1]

A. N. ARNESON, M.D.

THOSE WHO have spent some years in pleasant association with the members of this Society must surely find in that experience a rewarding degree of stimulation and fellowship. Arrival at that level of appreciation is not accomplished without understanding the traditions of the organization, which, in turn, are derived from proceedings in scientific and social assembly, and from the different personalities in the group. Thus, it is fitting that we choose a time during the Annual Meeting for reflecting upon the past and for honoring one of our more illustrious predecessors, Russell D. Carman.

Many of the earlier essayists, favored by appointment as speakers for this occasion, enjoyed personal and sometimes intimate friendship with Carman. One need only review their introductory remarks to become aware of the admiration and high respect with which they regarded his life and work. With the passing of time, some of those more recently selected, like myself, have known only the inspiration of his name, and the ideals and principles for which it stands. Perhaps we of that somewhat younger generation honor his memory with less emotion, but with equal regard for a high level of moral and professional leadership. It is probable that Carman might enjoy and appreciate the perpetuation of his name as a symbol of tradition in radiology, with wholesome influence falling upon the increasing flow of new arrivals in that specialty, and in fact upon medicine as a whole.

It would be presumptuous upon my part to attempt any elaboration upon the biography of Dr. Carman, which has been so well presented by those who have spoken to you before. I do hasten, however, to express my appreciation for this opportunity, and the honor I cherish in offering these remarks commemorating his name. That opportunity is particularly gratifying to one from the community in which Carman performed his early work. Those events in Saint Louis were most ably described in the lecture given a few years ago by Dr. Wendell G. Scott (1). Another regional consideration increases my appreciation. In the invitation extended by your president, Dr. Tom B. Bond, cognizance was taken of my origin from his community, with the assurance that he still considers me a representative of the Southwest. That factor may have more heavily weighted his judgment than my professional activity, which has drifted rather far afield from the course pursued by Dr. Carman. It is evident that Dr. Douglas Quick (2) experienced similar apprehension in presenting his discussion upon therapeutic radiology in 1947. In that address, however, he pointed out the fact that Carman was probably the first radiologist to give practical recognition to division of the specialty into diagnostic and therapeutic components. In the attempt to extend Dr. Quick's discussion, I will speak about certain inter-relationships between radiology and gynecology, and the difficulties inherent in the assessment of the relative merits of different therapeutic approaches to cervical cancer.

The favorable response that many conditions of the female genital tract show to irradiation, and their accessibility for radium treatment, are basically responsible for certain parallel interests shared by the radiologist and the gynecologist. Gynecologists promptly appreciated the poten-

[1] From the Department of Obstetrics and Gynecology and the Mallinckrodt Institute of Radiology, Washington University School of Medicine, Saint Louis, Mo. Delivered before the Radiological Society of North America, Chicago, Ill., Dec. 13, 1955.

tialities of radium in treating cervical cancer. The history of their activity in this field is to be found in the Janeway Lectures presented by Curtis F. Burnam (3) in 1936 and by Frederick W. O'Brien (4) in 1946. This overlapping of interests has served to bring radiologists and gynecologists together. As a result, the knowledge and experience accumulated by one specialty have permeated the other.

While the overlapping of interest was once concerned chiefly with clinical practice, it has now extended into the fields of graduate and undergraduate instruction. Although evidence of cooperative teaching programs in radiology and gynecology is scant, they do exist through the media of tumor boards and clinics. Morton (5) has reported some data accumulated at the graduate level in a survey of education in obstetrics and gynecology conducted by the American Gynecological Society. Six institutions reported to him that joint conferences upon the radiological treatment of gynecological cancer were being held, and one mentioned the tumor conference as a special feature in resident training in gynecology. It is probable that others should be included, because at least two university clinics with well coordinated plans of joint instruction failed to indicate what they did. Team teaching technics have undoubtedly been stimulated by the recent Public Health Service grants to medical schools, and certain results of that program have been reported by Kaiser (6). Although the original intention was to support undergraduate instruction in cancer, support is now being extended to both graduate and undergraduate education. Furthermore, there is increasing realization of the necessity of cooperative teaching tumor clinics to provide opportunity for joint learning to all individuals dealing with problems in neoplasia. I believe this tendency to be good.

One of the things that has disturbed some individuals is the lack of interest of the top-notch student in either gynecology or radiology. The American Gynecological Society survey was initiated in the attempt to ascertain why obstetrics and gynecology fails to attract its share of "talented" medical graduates. Gardner (7) extended this work in a special study among graduates of Northwestern University. Board certification was correlated with grade achievement in undergraduate work for the classes of 1934 to 1943 inclusive. Although several specialties, including obstetrics and gynecology and radiology, collectively accounted for a large percentage of those certified, all attracted less than a proportionate share from the upper levels of the respective classes. Gardner's report indicates that obstetrics and gynecology, as well as radiology, must improve their appeal to the "talented" graduate if they are to gain superior recruits. Here we, the radiologist and gynecologist, have a common problem—the acquisition of superior manpower. Perhaps we can solve the problem jointly.

Resident educational programs must be responsive to changes in the perspective of treatment. For a time there was almost complete unanimity of opinion that all cases of cervical cancer should be treated solely by irradiation. That belief is now less firmly held, chiefly because of the work of Meigs, and his demonstration that there is a place for surgery in the modern treatment of this disease. One of the major surgical indications is in the management of post-irradiation persistence or reappearance of cancer. The place of radical hysterectomy as a primary measure, however, is still undetermined and will remain so until some method is developed for selecting those patients likely to show a poor radiation response. The radical procedure developed by Brunschwig has extended surgical treatment to very advanced cervical cancer. Pelvic exenteration has met with varied responses, as illustrated by Emge's discussion of Parson's recent publication (8). The procedure has, nevertheless, brought relief to some patients having distressing symptoms, and presenting a completely hopeless situation. Consequently, evaluating its effectiveness upon

the basis of palliation may be more realistic than doing so upon the basis of longevity.

Concurrent with the change in perspective in relation to surgery, there has been a change in the perspective of radiotherapy. In the past the radium treatment of gynecological lesions largely fell into the category of minor operative work. The introduction of interstitial irradiation of the parametrial and paravaginal tissues with needles and radioactive gold has made radiotherapy more complex surgically. The use of needles has been found practical by some workers, though it has been condemned by others. Treatment by radioactive gold is still in an experimental stage, but it has produced promising results. Any increase in complexity of treatment enhances the risk to the patient. None the less, it is not foreseeable that any method will remain standardized for long, provided we work at assessing and improving our therapeutic approach. Radiologists have not as a group been as forward as gynecologists in attempting the more intricate procedures. That is probably related to their more limited experience in surgical technic. The failure of radiologists and gynecologists alike to master newer technics may be ascribed to an inadequacy in graduate training common to both specialties, mainly in the field of surgical experience.

Before we give further consideration to the training of radiologists and gynecologists, it is important that we establish our present level of accomplishment in the treatment of cancer of the cervix. The wide latitude in recovery rates reported by different clinics indicates that a particular series of patients may not be representative of the total experience. Extensive data on cervical cancer have been accumulated in the several volumes of the *Annual Report on the Results of Treatment in Carcinoma of the Uterus*. The most recent volume, published in 1955 (9), includes statements from 84 institutions in 20 different countries. For the last five years of the study, 1944–48, the relative apparent recovery rate is 39.8 per cent. That figure is undoubtedly higher than the general average, since all of the collaborating clinics have a considerable experience in the treatment and follow-up of cancer patients.

TABLE I: CARCINOMA OF THE CERVIX: RELATIVE APPARENT RECOVERY RATE, COLLECTED STATISTICS, 1944–1948

(Data from Tenth Annual Report on the Results of Treatment of Carcinoma of the Uterus, 1955)

Clinical Stage	Patients Treated	Five-Year Recovery
I	6,660(19.3%)	64.9%
II	13,294(38.5%)	46.0%
III	12,096(35.0%)	26.0%
IV	2,477(7.2%)	7.2%
	34,527(100.0%)	39.8%

Each successive publication of the *Annual Report* has shown a slight advance in relative apparent recovery rate. The data have been studied exhaustively by the Editorial Committee, of which Dr. J. Heyman is chairman, and the advance has been attributed to the effect of an increasing number of cases presented by new collaborators, changes in quality of clinical material, and improvement in treatment. Approximately 35,000 patients are included in the latest five years of the *Report*. The distribution of those cases by stages, in accordance with the International Classification, and the relative apparent recovery rate for each group are shown in Table I.

Among the collaborating institutions are a few with responsibility for the treatment of all patients within a geographically defined area. In the seventh volume, data from those clinics were used to construct for cervical cancer a standard error curve showing, for different numbers of patients, the expected range in percentage of lesions falling into Stage I and II. The various uncertainties decrease, as is to be expected, with increase in total number of patients. For any particular series, the curves afford a standard for detecting selectivity in relation to the total experience within the geographic area specifically defined.

Any attempt to compare average results at different institutions is apt to be complicated by selectivity. It is more practi-

cal to employ the different clinical stages, despite variations that may occur in classification. Selectivity also makes impossible a direct comparison of results from surgery, or from other procedures such as those employing needles or radioactive gold, except in so far as the use of those methods may affect the year-to-year results in a single institution. With increase in the number of patients treated surgically, editors of the *Annual Report* have, however, attempted an evaluation in spite of the difficulties involved. The results from clinics favoring primary hysterectomy have been compared with those from institutions with an insignificant number of operations, performed only because of failure of radiotherapy. Other criteria are established to assure a maximum of validity. Among those favoring surgery in a large percentage of their cases, the five-year survival rate is given as 62.9 per cent for Stage I and 42.9 per cent for Stage II. The corresponding figures for the clinics employing radiotherapy are 65.9 per cent and 47.4 per cent. It is concluded that no apparent need for primary surgery exists where adequate radiotherapy is available.

The place that surgery occupies in the modern treatment of cervical cancer is better shown by reviewing a particular experience, and in that attempt Dr. Joe V. Meigs has permitted use of some of his data not yet published. He believes that patients given preoperative irradiation should be omitted in arriving at a straight surgical result. They belong to radiation statistics, since, depending upon the persistence or absence of cancer in the operative specimen, they fall into the class of either radiation failure or cure. Including those patients in surgical data increases the selectivity factor, due to the difference in five-year survival of the two classes. In Meigs' series of 131 patients are 49 who received preoperative irradiation. Of that number, 20 were found at operation to be without evidence of residual cancer. These cases, classed as "radiation cures," show a five-year survival rate of 95 per cent. For the 29 "radiation failures," with evidence of residual cancer at operation, the corresponding figure is 62 per cent. Primary radical hysterectomy alone was employed in 61 patients, with 55, or 90 per cent, alive and well at the end of five years. In determining the straight surgical result, however, Meigs includes 10 additional patients treated by that method but subsequently requiring postoperative irradiation for evidence of surgical failure. Three of those patients are apparently well, but these he has eliminated from the number of "cures" because their survival is attributed to the postoperative treatment. Thus, for a straight surgical result he cites survival of 55 patients among 71 undergoing primary radical hysterectomy, a cure rate of 77.5 per cent.

The data given by Dr. Meigs present a fair and conservative appraisal of surgery. While it is obvious that selectivity prevents direct comparison with other methods, it is improbable that better results would be found for the same selectivity applied to an irradiated series. Evidence of superiority is not established, but in the treatment of certain patients it is apparent that surgery has a place equal to that of the better methods of irradiation, provided the operative procedure equals that performed by Meigs. Mention should also be made of the surgical results among patients showing radiation failure. Survival of 60 per cent is well above what is to be expected from secondary irradiation.

Selectivity applies also to many series of patients treated by irradiation, as is shown in the 217 private patients treated by the author during the years 1935 through 1950. Of that number, 77 per cent are classified in Stages I and II, which is a figure well outside the standard error curves mentioned above. The ward cases treated during the same period coincide more closely with the standard, but the total number fails also to fall within the curves in question. The private series represents all except 5 of the primary cases, including cancer of the cervical stump, examined with a view toward treatment

during the specified period. The 5 unirradiated cases were either too far advanced for treatment or were treated elsewhere. Intra-epithelial lesions have been excluded. The five-year end-results according to the various clinical stages are given in Table II. The recovery rate for Stage I is 82.5 per cent, and for Stage II 61.9 per cent. For Stage III the rate of survival without evidence of recurrence is 34.8 per cent. None of the few patients in Stage IV lived for five years, nor have there been survivals among ward cases in that stage. Cystoscopy and proctoscopy have not often been utilized in classification of patients. Those falling into Stage IV have usually had gross clinical evidence of bladder or rectal involvement, or definite proof of distant metastases.

Throughout each of the years in question this private series of patients has shown a better clinical result than the ward series for the same period, though the treatment has been essentially identical. The difference is believed due to the better health and nutrition of the private patients, a lower incidence of infection, and lesser loss to follow-up. Since 1950, a substantial number of ward patients have been treated with parametrial injections of radioactive colloidal gold in conjunction with radium and radical hysterectomy. Five-year data are not yet available, but in the one- to four-year results there is evidence of improvement extending above the corresponding values prevailing among the private patients treated during the same period. The incidence of complications has not been definitely established. The technical procedure has been performed by a limited number of the staff, including a few gynecological residents. An increase in sequelae might be anticipated with more general use of the method.

The development of newer technics of treatment necessitates the expenditure of considerable time and effort. Years of observation may be required to ascertain fully the relative merits of a particular procedure. The difficulties encountered in evaluating surgery have been discussed.

TABLE II: CARCINOMA OF THE CERVIX: RELATIVE APPARENT RECOVERY RATE FOR PRIVATE PATIENTS, 1935–1950

Clinical Stage	Patients Treated	Five-Year Recovery
I	63(29.0%)	52(82.5%)
II	105(48.4%)	65(61.9%)
III	46(21.2%)	16(34.8%)
IV	3(1.4%)	0
	217(100.0%)	133(61.3%)

A problem of equal magnitude is found in attempting appraisal of results from supervoltage irradiation.

At no time has any particular development produced a sharp increase in survivals. The relative recovery rate for cervical cancer has followed a slow advance. We know little about absolute recovery. As a matter of fact, our data on relative values are not necessarily indicative of the total experience. Most of our statistical information comes from sources with considerable experience in the treatment and follow-up of cancer patients. It can be assumed that the results are superior to the general average. We do not know the number of patients treated at units less well prepared, but it is probable that they represent a substantial segment of the total clinical material. There is reason to believe that application of the better technics to this group could produce a sharp increase in the overall favorable results. The use of x-rays and radium has cured more cases of cervical cancer than any other method. It is the treatment most widely used at the present time, and it is the method upon which we have accumulated the greatest amount of experience. Improvement in that technic at the less well organized institutions is the objective that concerns me most. I believe the radiologist may be the key to solution of the problem.

Suppose we face squarely the facts at hand. Radium is readily available to any physician interested in its use. There are no restrictions or limitations of any kind. There may be moral questions involved, but that is outside our discussion here. Once the diagnosis of cervical cancer is

established, the patient may be referred to a radiologist for external irradiation. Both the referring physician and the radiologist may lack experience of the natural history of the disease. Since the treatment involves radiotherapy, dependence is placed upon the radiologist for advice and recommendations. If his interest and experience are chiefly in the field of diagnosis, he is apt to develop a standard set of procedures that fail to integrate external irradiation with radium treatment. Recommendations for radium may not take into account the clinical findings on examination. The decisions made at that time are of critical importance to the patient.

It is not to be implied that we are riding upon the horns of a dilemma. The more recent graduates from residency programs are far better equipped than were their predecessors. They may contribute to the solution of the problem by utilizing one of the natural functions of the radiologist. He serves as a consultant more frequently than any other specialist. His opportunity for enlightening others is unlimited. We need to remind ourselves, however, that radiotherapy carries risks as great as those inherent in major surgery. It would seem as necessary to give extensive training in radiotherapy to residents in radiology as it is to give prolonged training to residents in gynecology. The radiologist so qualified should not assume responsibility for external irradiation if he cannot depend upon good radium technic on the part of the gynecologist. He must be prepared to give aid in the application of that procedure, or to perform the operation himself. The same reasoning applies, in reverse, to the gynecologist with experience in radiotherapy.

Residency training programs in gynecology are of necessity equipping graduates with an increasing knowledge of radiotherapy. The effects of this are not yet apparent, but it entails the risk of reducing the quality of training provided the radiologist, and ultimately limiting his activity to external irradiation and to the procurement and processing of radioactive isotopes. In short, with the expansion of radiotherapeutic training of gynecologists, there is danger that we emasculate the therapeutically minded radiologist. We should not do that, but we cannot permit radiation therapy to remain static. To prevent this, why not train the therapeutically minded radiologist surgically? Individuals far better equipped than I have wrestled with these questions without finding an answer. Furthermore, I have no misconception concerning the cool reception that would be given the suggestion that roentgen diagnosis be separated from radiotherapy, but in that connection I cannot escape inquiring if this audience is aware that similar pressures have fallen upon obstetrics and gynecology.

From a practical point of view there are valid reasons for opposing splitting radiology into diagnostic and therapeutic divisions, just as there are valid reasons for opposing a separation of obstetrics and gynecology. It is still possible to see the whole picture in both disciplines, though with difficulty. There is, however, closer relationship between the management of parturition and diseases of the female genital tract than there is between the roentgen diagnosis and therapy of cancer. Furthermore, the scope of radiology has broadened to a degree that brings into question the practicability of one individual encompassing all details within the entire field. The practice of surgery is compartmented into well defined anatomical divisions, but certification by a particular specialty board does not alone qualify the individual to treat all cancers. There should be opportunity for one to follow his natural bent. In brief, there should be equal opportunity for those interested in the treatment of cancer, whether as radiologist or gynecologist, to extend their knowledge of radiotherapy. Establishing opportunities for graduate instruction for radiologists and gynecologists alike should increase the appeal to the "talented" students for a career in radiology, as well as in obstetrics and gynecology.

The necessity of participation in a teach-

ing tumor clinic for learning the natural history of cancer has been noted. It is the principal means whereby bilateral experience in radiotherapy and gynecology can be developed and practiced. Tumor board or conference meetings do not alone provide adequate opportunity. A gynecological tumor clinic, coordinated with similar activities of other clinical departments, can function autonomously for the diagnosis, treatment, and follow-up of patients with cancer of the female genital tract. Each radiological resident, in addition to regular training in roentgen therapy, could be given an assignment in the clinical application of radium and isotopes to pelvic cancers. During that period he would participate actively in the gynecological tumor clinic and be a regular member of the operative team at every radium treatment. It can thus be seen that a tumor clinic and related in-patient service can bring experience to radiologic and gynecologic personnel alike, despite the fact that their educational programs are primarily within their respective areas. The common bond in cervical cancer necessitates an understanding of the natural history of the disease for both specialists. The system of registries and clinical activities adopted by the American College of Surgeons for approval of cancer programs can well be the means to that end. It could be extended to require cooperative teaching tumor clinics at most levels of organization.

Our customs in clinical practice are such that the gynecologist functions more or less independently in the diagnosis and follow-up of patients. While there are exceptions, the radiologist for the most part is isolated from experience in those aspects of the disease. From the earliest days of radiotherapy the gynecologist entered that field through the use of radium. With the treatment of cancer growing increasingly more complex, there is a tendency to concentrate patients at certain institutions. At even that level, however, the gynecologist has, by necessity, developed an increasing interest in radiotherapy. Had we in this country practiced a split in radiology, I do not believe that these same circumstances would exist. We cannot say which would most benefit the patient, but it is apparent that the gynecological interest has been responsible for maintaining a balance in surgery and irradiation. In the course of time, that may prove to be of value.

At the Seventh International Congress of Radiology, both Paterson and Shanks presented their interpretations of the advantage of separating diagnostic and therapeutic radiology in Great Britain. I dare say that those principles, combined with concentration of patients, present a challenge to the total experience in this country. The average gynecologist comes infrequently into contact with cervical cancer. There is no essential reason why he should have broad experience in radiotherapy. The average radiologist tends to concentrate the combined experience of several gynecologists. There is every reason why he should have experience in radiotherapy. We know neither the number of patients treated at the average level, nor do we know the clinical results that have been obtained. The ultimate solution may be a problem in referral, but in the meanwhile the radiologist is a key figure in resolving the difficulty. Dr. W. Edward Chamberlain has described the situation by referring to what he chooses to call "general practitioners" of radiology. The radiologist is a specialist. Extending our educational programs in radiotherapy should be an important forward step in meeting the responsibility.

There is a tendency for all of us to appraise situations according to personal experience, which is often the result of chance and circumstance. My professional activity has to a considerable degree been associated with an expanding interest in radiotherapy developing within the scope of gynecology. The opportunity I have enjoyed in a dual academic appointment came about some years ago through the foresight of Dr. Sherwood Moore and Dr. Otto Schwarz. Their successors have

made provisions for continuing that philosophy. It is not to be implied that the same plan is applicable to all institutions, and perhaps my experience is largely the result of a phase in evolution. I should be remiss in failing to state that earlier experience in the physics laboratory of Dr. Failla and Dr. Quimby made possible the meeting of responsibilities enjoyed in my institutional assignment. At some time in the future another individual may perhaps express equal gratitude for experience in biology. If, in the meanwhile, these circumscribed remarks facilitate the clinical career of one young aspirant in radiotherapy, they will accomplish their mission as a tribute to the memory of Russell D. Carman.

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SUMARIO

La Conferencia Carman—La Relación Clínica de la Radiología Terapéutica y la Ginecología en el Tratamiento del Cáncer Cervical

En la respuesta favorable que muchas dolencias del aparato genital femenino manifiestan a la irradiación y en la accesibilidad de las mismas a la curieterapia reconocen fundamentalmente su origen ciertos intereses paralelos que comparten el radiólogo y el ginecólogo. Aunque la esfera entremezclada de las dos especialidades comprendía antes principalmente la práctica clínica, hoy día se ha extendido a la rama educativa.

Está demostrado que la cirugía tiene su puesto en el tratamiento del cáncer del cuello uterino y que en el implante de radio figuran varias medidas de cirugía menor. Los planes de adiestramiento en ginecología para médicos residentes prestan cada vez más atención a la radioterapia. ¿Por qué, pues, no preparar en cirugía al radiólogo inclinado a la terapéutica? En este último sentido se discute la cuestión de separar la radiología en divisiones de diagnóstico y de terapéutica.

Tanto el radiólogo como el ginecólogo necesitan una comprensión de la historia natural del cáncer, y esto lo ofrece mejor la clínica cooperativa de tumores con un servicio anexo de enfermos hospitalizados.

Se ofrecen estadísticas recopiladas de los resultados del tratamiento del carcinoma del cuello uterino y se presentan los resultados obtenidos por el autor mismo.

Cranial Manifestations of Familial Metaphyseal Dysplasia[1]

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FAMILIAL metaphyseal dysplasia (Pyle's disease), characterized by idiopathic symmetrical metaphyseal splaying of the tubular bones, has been considered one of the rarest of the generalized osseous dysplasias. Pyle's patient, described in 1931 (1), and a sibling with identical findings described by Bakwin and Krida in 1937 (2), were generally regarded as unique in the annals of medical reporting for nearly twenty years. Recent observations, however, indicate that the disorder is not as rare as was previously supposed and that strikingly characteristic cranial manifestations may accompany the metaphyseal splaying. Our purpose in presenting this paper is to report 3 cases of combined cranial-metaphyseal dysplasia and to suggest that this disorder represents a distinct clinical and roentgenologic entity worthy of more widespread recognition than it has been accorded in the past.

Among the more significant recent contributions bearing upon this disorder is that of Neuhauser, who in his 1952 Caldwell Lecture (3) called attention to cranial abnormalities in a case of familial metaphyseal dysplasia, noting the similarity to the skull defects sometimes seen in polyostotic fibrous dysplasia. In 1953 Hermel, Gershon-Cohen, and Jones (4) described a brother and sister with truly spectacular metaphyseal dysplasia. Sinuses and mastoids were found to be incompletely pneumatized in the brother, for whom roentgenograms of the skull were obtained, but no other cranial abnormalities were evident. Perhaps the most important recent report is that of Halliday (5), who in 1949 described a rare case of bone dystrophy in a nine-year-old girl with splayed long bones and extraordinary hyperostosis of various portions of the skull. Since the cranial abnormalities predominated in this patient, the metaphyseal dysplasia was not emphasized, but the unusual nature of the case was fully appreciated and exhaustive clinical investigation was eventually followed by detailed postmortem examination. The clinical and roentgenologic findings in Halliday's case are virtually identical with those in the 3 cases to be recorded here, cranial deformities being outstanding features in all instances.

CASE REPORTS

CASE I: J. V., an 8-year-old white boy (born Jan. 27, 1944) was admitted to the University of Michigan Hospital on July 13, 1952, and again on June 29, 1953. Gestation and delivery had been uneventful, and the child had appeared normal at birth and in early infancy, during which time bottle feedings were adequately supplemented by vitamins.

At the age of seven months, the parents noted marked lateral nystagmus of both eyes, excessive tear formation, inability to use the facial muscles for laughing or crying, and a tendency to nasal obstruction. No treatment was prescribed at this time.

In general, growth and development were normal. At four years of age glasses were prescribed for defective vision. Partial deafness was first observed when the child attended school. On his first hospital admission, for chronic otitis media, he had completed the second grade with good marks, despite visual and hearing handicaps. Tonsils and adenoids were removed at this time, without significant improvement in hearing. The patient had chickenpox at five years of age and measles at seven, without complications.

Both parents were living and well. A sister, ten years of age, was well. There was no family history of abnormality similar to that of the patient.

On physical examination the boy appeared intelligent but emotionally upset because of the attention focused upon his facial deformities. His height was 53 inches; weight 68 pounds. A single small *café au lait* spot was present on the neck. The head was large—60 cm. in circumference—and of a scaphocephalic type with prominent frontal and parietal bosses.

Pronounced hypertelorism was observed, the distance between the inner canthi being 50 mm.

[1] From the Department of Radiology, University of Michigan, Ann Arbor, Mich. Accepted for publication in February 1955.

Fig. 1. A. Case I. Typical facies characterized by hypertelorism, broad flat nose, and defective dentition.
B. Case II. Facial appearance strikingly similar to Case I.

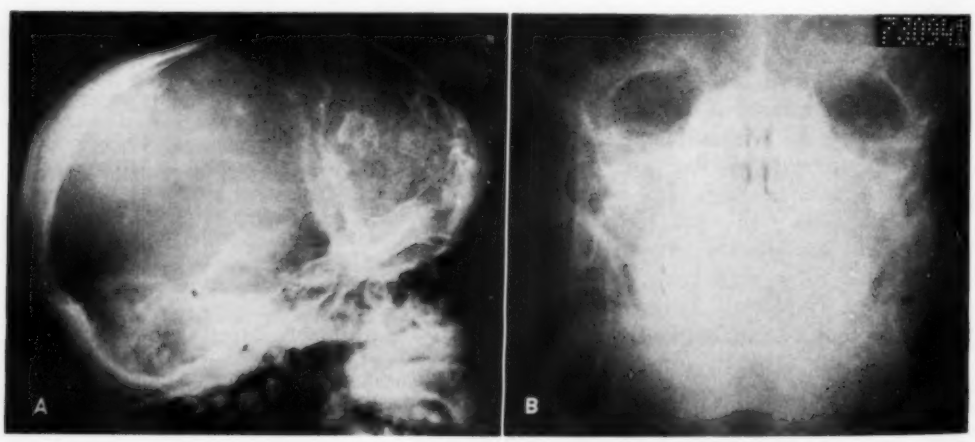


Fig. 2. Case I. A. Characteristic hyperostosis of vault, base, and facial bones; retarded pneumatization of sinuses and mastoids; accentuated ossification of sutures, and patchy internal hyperostosis of frontal bone. The diploic space is largely obliterated.
B. Waters' view, showing diffuse hyperostosis of facial bones, lack of pneumatization of antra and ethmoids, and narrowing of nasal fossae.

(Fig. 1A). The face was expressionless because of bilateral peripheral facial paralysis. There was bilateral spontaneous nystagmus of the seeking type. The nasolacrimal ducts were occluded bilaterally. Pupillary and extra-ocular movements were normal. Funduscopic examination showed bilateral optic atrophy. Visual acuity was profoundly diminished. Audiometric examination was indicative of marked bilateral deafness. On first admission, all of the deciduous teeth were present.

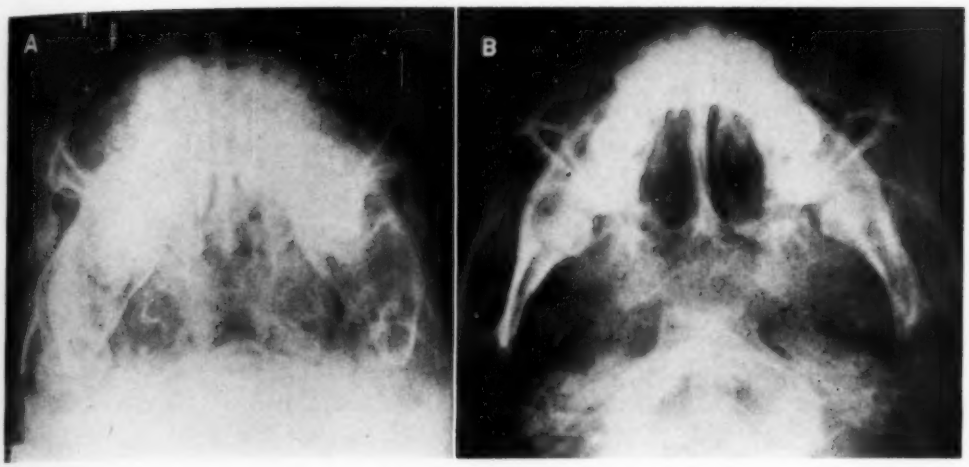


Fig. 3. A. Case I. Base view illustrating spectacular thickening of mandible, hyperostosis of base with encroachment on neural foramina, lack of pneumatization of sphenoids and antra.
B. Normal base view for comparison.

The anterior deciduous teeth were removed at the time of tonsillectomy, and on second admission only the lower two incisors of the permanent teeth had erupted.

The heart, lungs, and abdomen were normal. The extremities also appeared normal, except that the lower ends of the femurs felt large. Reflexes were equal but somewhat hypoactive.

Pertinent laboratory findings were as follows: hemoglobin 13.1 gm.; serum calcium 9.8 mg.; serum phosphorus 4.7 mg.; alkaline phosphatase 7.8 King-Armstrong units; urine negative; tuberculin and histoplasmin skin tests negative.

On roentgen examination, the entire cranial vault, the base of the skull, the facial bones, and the mandible were seen to be composed of remarkably thick bone (Figs. 2 and 3). The thickening in the vault was most marked in the parietal, occipital, and inferior frontal regions, reaching 2.7 cm. in the occipital area. The diploe was obliterated, and the margins of the sutures showed bony condensation. Unusual patches of sclerotic bone were evident on the inner table of the frontal bone.

The orbits were widely separated. The nasal chambers were small, due to the bony overgrowth, and the nasal bones were broad, flat, and dense. The paranasal sinuses were not pneumatized but were replaced by dense bone (Fig. 2B). No pneumatization of any part of the temporal bone was apparent. The internal auditory canals, foramina at the base of the skull, and optic foramina were encroached upon by the bony overgrowth. The clinoid processes were thickened. Dentition was delayed.

Chest films revealed no evidence of pulmonary or cardiac abnormality. The ribs and clavicles were increased in caliber but were not sclerotic. The spine appeared normal except for spina bifida of the first two sacral segments.

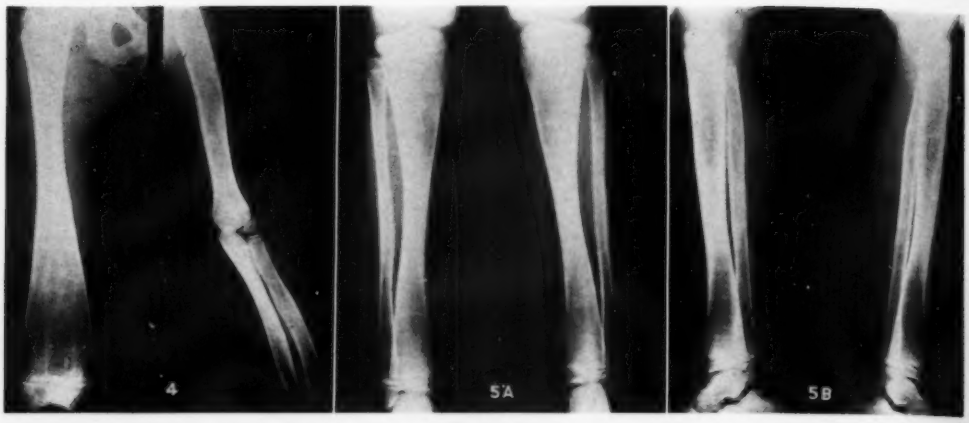
In the long bones a symmetrical widening at the growing ends (Figs. 4 and 5) was demonstrated. The cortex was thin toward the ends but of normal density in the mid-diaphyses. Bilateral coxa valga was observed. Medial bowing of the femoral shafts and sinuous bowing of the tibias with the inward convexity above resulted in genu valgum (Fig. 5). There were numerous growth lines in all the long bones, most prominent in the tibias, where they extended deep into the central portions of the diaphyses (Fig. 5B).

CASE II: K. G., an 8-year-old white boy (born March 1, 1945), was admitted to the University of Michigan Hospital on March 17, 1953. Gestation, delivery, and growth had been normal. The only childhood diseases were chickenpox in 1950 and measles in 1952, with no sequelae. In 1950 the child had otitis media, and on recovery his tonsils and adenoids were removed. Not long afterward some difficulty in hearing was noticed by the parents. Hearing loss was progressive and eventually the patient was admitted to University Hospital for evaluation of this complaint. System review revealed nothing unusual.

The father, thirty-three years of age, had been partially deaf since birth. The mother, thirty-two, had had progressive hearing loss since about eight years of age. One male sibling was well, with normal hearing.

The patient was pale, tall, and thin. The body height was 52 1/4 inches; weight 62 1/2 pounds.

Moderate hypertelorism and prominence of the frontal bone were observed (Fig. 1B). The head circumference was 56 cm. The mastoid bones were



Figs. 4 and 5. Case I. 4. Splayed configuration of right femur and bones of left arm due to decreased tubulation. There is thinning of cortical bone in the distal femur, radius, and ulna, and in the proximal humerus.
5A. Anteroposterior view of both lower extremities, showing splayed configuration of bones with sinuous curving, cortical thinning of metaphyses, and numerous "growth" lines.
5B. Lateral views of lower extremities. The "growth" lines are seen to better advantage.

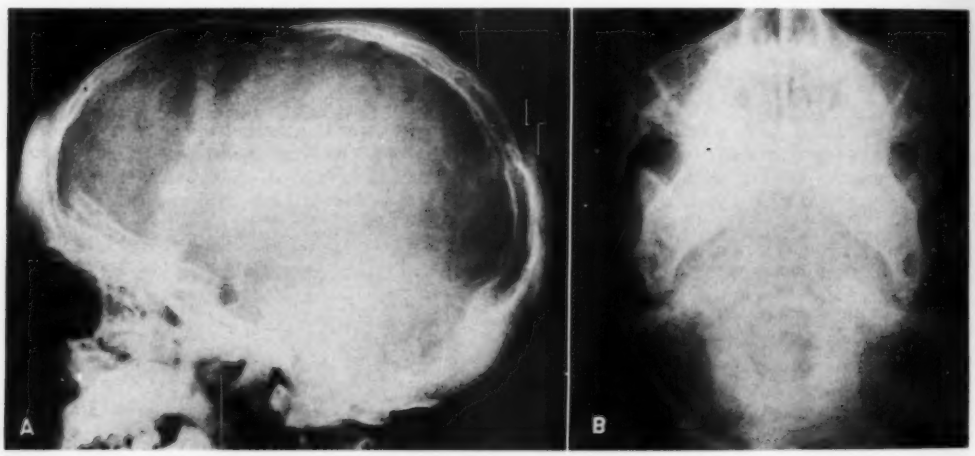


Fig. 6. Case II. A. Diffuse hyperostosis of vault, base, and facial bones; lack of aeration of sinuses and mastoids; condensation along cranial sutures.
B. Symmetrical thickening of mandible; hyperostosis of base with encroachment on neural foramina; lack of pneumatization of sphenoids and antra.

exceptionally prominent and the nasal bridge was flat and broad. General and funduscopic examinations of the eyes were negative. Audiometric examination revealed marked bilateral deafness. The chest, heart, abdomen, and extremities were normal, as were routine laboratory findings.

Roentgen examination showed the same abnormalities of skull and long bones as were found in Case I, with minor variations (Figs. 6 and 7). The mastoid processes were exceptionally prominent in spite of complete lack of aeration of any part of the temporal bone. The unusual patchy hyperostosis of the frontal bones seen in Case I was lacking.

CASE III: E. G., aged 32, the mother of K. G. (Case II), gave a history of scarlet fever at the age of six. No other unusual event was recorded. Between eight and ten years of age, a gradual loss of hearing ability developed, progressing to almost complete deafness, even with a bone-conduction hearing aid. On physical examination, the same striking craniofacial features were observed as in her son; the findings were otherwise negative.

Information was obtained on 22 members of this family and it was found that 5 of them were deaf. These were, in addition to the son and mother described here, the father, a maternal uncle, and the

maternal grandfather. Whereas the father had none of the prominent craniofacial features of his wife and son, both the maternal uncle and the maternal grandfather had the same unusual appearance. This relationship of unusual facial features and deafness in 4 members of one family suggests that in this instance at least the pattern of transmission was that of a simple dominant gene.

Roentgenograms of the skull and long bones showed a process identical with that in Cases I and II (Figs. 8 and 9). There was partial aeration of the antra, but the remaining paranasal sinuses were undeveloped.

Fig. 7. Case II. Femurs with valgus deformity, medial bowing, and splayed configuration.

Fig. 8. Case III. Thickening of cranial vault, base, and facial bones. Lack of pneumatization of mastoids and sinuses except antra, which are partially aerated.

Fig. 9. Case III. Typical metaphyseal dysplasia of right femur and left tibia and fibula. Opposite bones were symmetrically involved.

DISCUSSION

The distribution of the osseous lesions in familial metaphyseal dysplasia is striking. Bones of purely membranous origin (the flat bones of the skull) or of partly membranous origin (base of the skull, face, and mandible) show a fairly uniform hyperostosis. Endochondral bones with profound growth tendencies (the appendicular skeleton) reveal a failure of modeling but no hyperostosis. In endochondral bones in which little growth occurs (sternum, epiphyses of all long bones, vertebral bodies, tarsal and carpal bones) no roentgen abnormality is evident.

John Hunter (6) and others (1, 7–9) have suggested that the modeling in long bones is due to periosteal resorption of bone

laid down at the growing ends. For this process Jansen (10), in 1928, suggested the term "tubulation." Failure of normal tubulation may thus be attributed to some deficiency of resorption. If the cranial hyperostosis in familial metaphyseal dysplasia could be accounted for by failure of normal periosteal resorption, all of the osseous changes would have a common denominator. Until more is known of the processes involved in bone matrix formation and resorption, the etiology and pathogenesis of this entity will remain an enigma.

Systemic manifestations associated with familial metaphyseal dysplasia have not been observed by other investigators or by us; the clinical features depend entirely on the osseous changes. It should be emphasized that the process is variable in degree. Changes limited to long bones may go unrecognized, in the absence of obvious clinical findings. This is graphically illustrated by the cases reported by Hermel *et al.*, in which the abnormality went unrecognized prior to examination by these observers despite several fractures.

The clinical findings which have been reported consist of knock knees, limitation of extension of the elbows presumably due to encroachment on the olecranon fossae by metaphyseal widening, delayed dentition, palpable fusiform enlargement of lower femurs and upper tibias, and disproportionately long lower extremities. In all cases laboratory findings have been normal. Pathologic fractures have occurred, but no delay in healing of bone has been observed (4).

If hyperostosis of the skull is present, additional clinical features are manifest. These consist of enlargement of the head and mandible, hypertelorism, broad flat nose, and cranial nerve abnormalities due to narrowing of the cranial foramina. Hearing loss occurred in all of our patients. Visual loss, epiphora, and peripheral facial paralysis were present in 1.

Prognosis depends on the extent of cranial involvement. The condition does not seem to interfere with general health except when cranial manifestations are present. Optic foramen decompression performed in an attempt to preserve vision may be of value in cases in which the foramina are narrowed. Death in Halliday's case was presumably the result of progressive cranial involvement.

Observations on pathologic material are limited to those made on the femur by Ingalls (11) and on the skull, vertebrae, and clavicle by Halliday. The skull in Halliday's case consisted entirely of compact, lamellated bone with haversian canals of various sizes. Soft tissue in the canals seemed unusually fibrous but not large in amount. In the femur in Ingalls' case there was a disturbance in the amount and disposition of bony tissue, but no distinguishing microscopic characteristics were observed. It appears likely that familial metaphyseal dysplasia is not a distinct histopathologic entity, although further studies obviously are needed before such a conclusion can be drawn.

Various authors have presented examples of a diffuse type of leontiasis ossea characterized by symmetrical hyperostosis of the cranial vault and base, the facial bones, and mandible. In some of these cases the appearance of the skull is identical with that in the patients in the present series. Splayed long bones are illustrated in reports by Stack (12, 13) and Gemmell (14), and there is good reason to believe that their cases are true examples of familial metaphyseal dysplasia. Perhaps if long bone observations were available, other cases now classified as leontiasis ossea of the diffuse osteitic type would fall into this group.

Anatomically, the name metaphyseal dysplasia is inappropriate for the entity under discussion. The metaphysis is the zone of growth of the diaphysis of bone (the epiphyseal plate). Actually it is a relatively narrow zone which gradually becomes even more narrow with growth and disappears with closure of the epiphysis. The use of the term metaphysis to refer to the terminal one-third or one-fourth of the diaphysis adjacent to the epiphysis has received wide acceptance. It is in this sense

that the term was used when the name familial metaphyseal dysplasia was originally coined by Bakwin and Krida (2). Notwithstanding the cranial manifestations which have since been described, it would seem unwise to suggest new terminology for an established entity.

Jansen (15), in describing an unrelated disorder, used the term metaphyseal dysostosis. Jackson (16) in referring to Jansen's case called it metaphyseal dysplasia. In order to avoid further confusion, the term metaphyseal dysplasia should be reserved for the entity described here and cases of the type described by Jansen should be recognized as a separate disorder.

DIFFERENTIAL DIAGNOSIS

The diagnosis of familial metaphyseal dysplasia is dependent on the roentgen observation of splayed long bones. Several other conditions in which this feature may occur must be differentiated. Symmetrical splaying of long bones may be caused by (*a*) bone marrow hyperplasia, (*b*) bone marrow infiltration, (*c*) deficiency states, (*d*) developmental abnormalities, or (*e*) toxic substances.

In the bone marrow hyperplasia group are included erythroblastic anemia and, rarely, sickle-cell anemia and chronic hemolytic icterus. When bone marrow hyperplasia is sufficient to produce a splayed appearance of the long bones, widening of the diploe in the skull and swollen contours of the metacarpals and phalanges may be expected. These findings provide the differentiation roentgenographically.

In the bone marrow infiltration group are Gaucher's disease and the leukemias. In the early form of Gaucher's disease the roentgen appearance of the long bones is virtually identical with that in familial metaphyseal dysplasia. In such cases differentiation is dependent upon the clinical and pathological observations. The predominant clinical findings in Gaucher's disease are progressive splenic enlargement and increased bleeding tendency. Hyperplastic reticulum cells containing kerasin are present in the bone marrow. In more advanced cases destructive lesions are present in long bones. The same is true of leukemia. Such lesions are not seen in familial metaphyseal dysplasia.

The deficiency states producing splayed long bones include fibrocystic disease of the pancreas, healing scurvy, and healing rickets. Clinical and pulmonary findings aid in the recognition of fibrocystic disease. Healing scurvy and healing rickets usually are sufficiently characteristic in themselves for a diagnosis. A moderate degree of cranial hyperostosis may be present in healing rickets.

The developmental diseases in which splayed long bones may be observed include osteopetrosis, gargoylism, and cleidocranial dysostosis. In osteopetrosis there is dense sclerosis of the cranial base and to a lesser degree of the vault. Differentiation is made by the diffuse sclerosis of the ends of the long bones, a feature not found in familial metaphyseal dysplasia. Hyperostosis of the skull and splayed long bones may on very rare occasions be seen in gargoylism. Other features of this condition provide a basis for differentiation. Although cleidocranial dysostosis, characterized by defective ossification of membranous bone with occasional associated failure of modeling of long bones, presents no problem in differential diagnosis, it is of considerable interest to speculate concerning the relationship between the basic mechanism in this abnormality and familial metaphyseal dysplasia.

Splayed long bones have been described in late lead poisoning (17). Lead poisoning must occur during bone growth, however, to affect the configuration. Lead lines are visible in these bones; they are heavier and thicker than the growth lines observed in familial metaphyseal dysplasia and are located uniformly and symmetrically above and below the knee.

Polyostotic fibrous dysplasia and progressive diaphyseal dysplasia, although not characterized by splayed long bones, should be considered in the differential diagnosis. In classical polyostotic fibrous dysplasia with cranial involvement, marked hyperos-

tosis of the base of the skull, with various degrees of thickening of the vault, is almost always found. The latter is usually asymmetrical and often includes areas of diminished density due to fibrous replacement. In all of our cases of familial metaphyseal dysplasia the cranial hyperostosis was symmetrical and homogeneous. The long bones in polyostotic fibrous dysplasia present cystic and sclerotic lesions sporadically distributed, with some tendency toward unilaterality. In familial metaphyseal dysplasia, there is no sclerosis of the long bones and involvement is perfectly symmetrical.

Progressive diaphyseal dysplasia is characterized by widening and sclerosis of the mid-diaphyses of long bones and in some instances by hyperostosis of the skull. It can be differentiated from familial metaphyseal dysplasia by the widening of the long bones in the mid-diaphyses rather than in the metaphyses.

SUMMARY

Characteristic cranial changes may accompany familial metaphyseal dysplasia. The principal features are diffuse symmetrical hyperostosis of the skull and mandible, with associated hypertelorism and obliteration of the paranasal sinuses. Encroachment on neural foramina may produce cranial nerve deficiencies.

The diagnosis of familial metaphyseal dysplasia is dependent upon the roentgen observation of splayed long bones. When typical hyperostosis of the skull is present in conjunction with splayed long bones the diagnosis can be established by roentgenograms alone. Long bone films should be obtained on patients having the diffuse symmetrical type of leontiasis ossea.

Three cases with characteristic cranial changes are reported. Evidence suggests that the condition may not be as rare as previously believed.

ADDENDUM

The increasing frequency with which familial metaphyseal dysplasia is being diagnosed is evident from the number of recent reports in the literature. Since submission of this report, 5 additional references have come to our attention. Reviglio (18) published in Italian a case having features identical in every respect with those presented here. He examined histologic material, but described no distinctive pathological features. Jackson *et al.* (19) published a comprehensive review of several of the osseous dysplasias. These authors reported 5 cases of familial metaphyseal dysplasia with cranial hyperostosis from the literature and added 1 other. Sommer (20), although not using the term familial metaphyseal dysplasia, described a typical case with cranial hyperostosis. Komins (21) reported 2 cases and obtained radiographs of the skull in 1. These showed the typical hyperostosis, although moderate in degree. Feld *et al.* (22) presented 2 cases with less advanced cranial findings.

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SUMARIO

Manifestaciones Craneales de la Displasia Metafisaria Familiar

Típicas alteraciones craneales pueden acompañar a la displasia metafisaria familiar. Las principales características son hiperostosis del cráneo y de la mandíbula, junto con hipertelorismo y obliteración de los senos paranasales. La invasión de los agujeros nerviosos puede producir deficiencias de los nervios craneales.

El diagnóstico de la displasia metafisaria familiar se basa en la observación roentgenológica de huesos largos aplanados. Cuando existe típica hiperostosis craneal unida a huesos largos aplanados, cabe establecer el diagnóstico con las radiografías solas. Otras dolencias caracterizadas por aplanamiento de los huesos largos, que requieren diferenciación, comprenden: hiperplasia de la médula ósea, como en la anemia eritroblástica; infiltración de la médula ósea por la enfermedad de Gaucher y las leucemias; estados de deficiencia, tales como enfermedad fibroquística del páncreas, escorbuto o raquitismo en vías de cicatrización; vicios del desarrollo, tales como osteopetrosis, gargolismo y disostosis cleidocraneal; y saturnismo tardío.

Preséntanse 3 casos con típicas alteraciones craneales. Los datos disponibles indican que la dolencia tal vez no sea tan rara como se creía antes.

Selective Angiocardiography in Infants and Children[1]

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MORE COMPLETE information of an anatomical and hemodynamic nature has been derived from angiocardiography in cases of congenital heart disease in recent years. It has become clear that, while venous angiocardiography with rapid serial biplane technics and short exposure times usually gives excellent results in small infants (1), absolute clarity on some specific points, and in older patients, is not always obtained. These limitations may be overcome by injection of Diodrast through a cardiac catheter placed in a more central position. The feasibility of intracardiac angiocardiography was first demonstrated adequately by Chavez *et al.* (2). Jönsson *et al.* (3) introduced the term "selective angiocardiography" to describe the method of opacifying limited and predetermined portions of the heart and great vessels. This procedure has been used by groups in Europe but at present its value has not been recognized widely on the North American continent.

The purpose of this paper is to re-emphasize the usefulness of selective angiocardiography in infants and children, both as a diagnostic and physiologic method.

TABLE I: CONGENITAL CARDIAC MALFORMATIONS IN 50 CHILDREN STUDIED BY SELECTIVE ANGIOCARDIOGRAPHY

Diagnosis		No. of Cases
Tetralogy or pentalogy of Fallot		17
Valvular stenosis	5	
Infundibular stenosis	5	
Combined stenosis	3	
Pulmonary atresia	4	
Transposition of great vessels		13
Complete (from left ventricle)	5	
Complete	4	
Complicated	4	
Tricuspid atresia (from left ventricle)		4
Ventricular septal defect		3
Moderate pulmonary hypertension	2	
Severe pulmonary hypertension	1	
True truncus arteriosus		2
Pulmonic stenosis with normal aortic root		2
Valvular stenosis	1	
Infundibular stenosis	1	
Auricular septal defect (from left auricle)		2
Complete anomalous pulmonary venous drainage (from pulmonary artery)		3
Atrioventricularis communis (from left auricle)		1
Miscellaneous		3
Pulmonary fibrosis (from right auricle)	1	
Primary pulmonary hypertension (from left ventricle)	1	
Aortic aneurysm (from pulmonary artery)	1	
TOTAL		50

NOTE: Unless otherwise stated the injection was from the right ventricle. Autopsy confirmation of the diagnosis was obtained in 13 cases.

METHOD

The patients, all infants or young children, currently receive for premedication a mixture containing "Largactil" (Chlorpromazine) 0.69 mg., Phenergan 0.69 mg., and Demerol 2.74 mg. per kilogram of body weight, by intramuscular injection, one hour before the angiocardiographic examination is begun. This usually results in light sleep on arrival at the laboratory and, although the patient may awaken during the attachment of electrodes, drapes, etc., he usually falls asleep again promptly. After local anesthetic infiltration and venous exposure, a No. 7 or No. 8 cardiac catheter is inserted at the groin and advanced to the central position of choice. A No. 6 catheter is less satisfactory because of low injection output. Either complete or abbreviated cardiac catheterization may be performed, depending upon circumstances in the individual case.

Diodrast in 70 per cent solution is injected rapidly through the catheter under a compressed air gauge pressure of 150 to 200 pounds per square inch. The dose of contrast medium varies according to the size of the heart and likelihood of dilution in the area to be studied, but is usually in

[1] From the Department of Paediatrics, University of Toronto, and the Research Institute of the Hospital for Sick Children, Toronto, Canada. Aided by a grant from the Ontario Heart Foundation. Accepted for publication in March 1955.

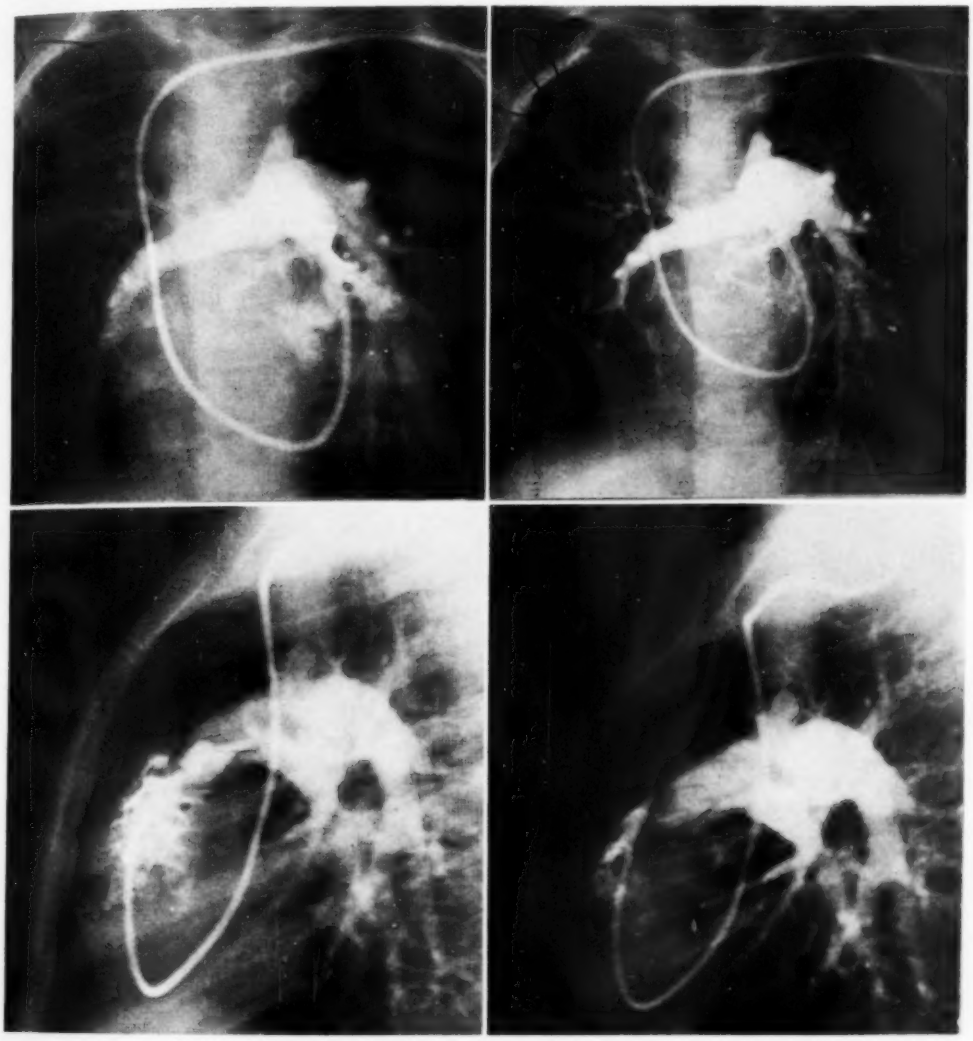

Fig. 1. Tetralogy of Fallot in a 4-year-old girl with moderate cyanosis and squatting. On cardiac catheterization the pulmonary artery was not entered. Pressure in right ventricle 105/10; aorta 105/75. The site of the right-to-left shunt was proved by aortic entry. Selective angiocardiography, with simultaneous anteroposterior and lateral views, and the catheter high in the outflow tract of the right ventricle, showed (*a*) pulmonic stenosis of dome type (jet best shown in the lateral view); (*b*) poststenotic dilatation of the left main branch of the pulmonary artery; (*c*) absence of aortic opacification due to the position of the catheter; (*d*) diverticulum at the origin of the left main pulmonary artery, presumably due to a ductus arteriosus closed at its aortic end.

the region of 1.5 c.c. per kilogram of body weight. With the Schönander biplane angiograph, as previously reported (4), between eight and ten cassettes are changed per second in anteroposterior and lateral views.

RESULTS

Twenty-nine infants and 21 older children (all but 6 under five years of age) have been studied by selective angiocardiography in our unit (Table I). No untoward reactions have been encountered in this group. An electrocardiograph coupled to the angiocardiograph marks the phase of the cardiac cycle at the time of exposure as well as providing an electrocardiogram for

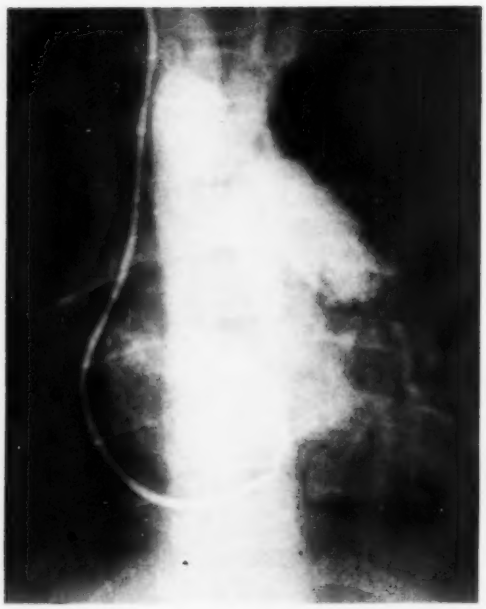

Fig. 2. Tetralogy of Fallot in a 7-year-old boy with moderate cyanosis and squatting. Cardiac catheterization showed combined valvular and infundibular stenosis with infundibular chamber. Pressures: pulmonary artery 7/2; infundibulum 50/5; inflow tract of right ventricle 75/5; aorta 70/45. The site of the right-to-left shunt was proved by aortic entry from the right ventricle. Selective angiocardiography with the catheter in the tricuspid valve region showed (*a*) ampullary dilatation of the outflow tract of the right ventricle between a localized mid-infundibular stenosis and the pulmonary valve; (*b*) faint opacification of the pulmonary artery branches; (*c*) Diodrast escaping into an overriding aorta with right arch and descending portion.

early indication of any serious disturbance of cardiac rhythm. A pressure record from the chamber concerned is obtainable before and after the procedure. This allows confirmation of the catheter position during necessary changes in posture prior to and following injection. In our experience, the catheter tip flips out of the chamber or vessel in which it has been placed in about 10 per cent of cases as a result of the pressure injection.

It will be noted that isolated patent ductus arteriosus and coarctation of the aorta are not included in the table. We prefer retrograde aortography for investigation of cases in which these anomalies are suspected, as previously stated (4, 6).

Tetralogy of Fallot serves as an excellent example of the superiority of the selective over the venous technic in certain cases of congenital heart disease. With the routine venous angiogram, consideration of the anatomy of the right ventricular outflow tract and the site of the right-to-left shunt is made difficult because of opacification of (*a*) a large right (and sometimes left) auricular chamber, (*b*) of the superior vena cava in the lateral view, (*c*) and of a left ventricle with a right-to-left shunt between

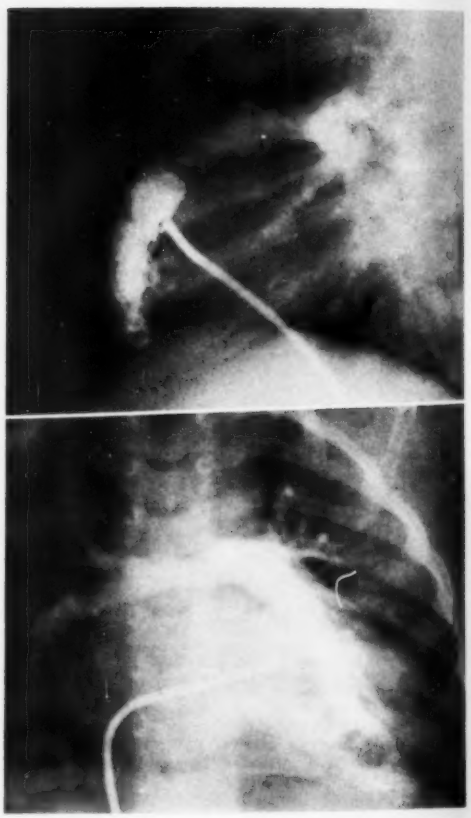

Fig. 3. Tetralogy of Fallot in a 2 1/2-year-old boy with slight cyanosis and effort dyspnea. Cardiac catheterization showed combined valvular and infundibular stenosis. Pressures: pulmonary artery 20/5; infundibulum 60/5; inflow tract of right ventricle 100/10; aorta 100/60. The site of the right-to-left shunt was proved by aortic entry from the right ventricle. Selective angiocardiography was done with the catheter in the mid right ventricle. The lower (anteroposterior) view was not of assistance in determining the site of stenosis. The upper (lateral) view shows an infundibular chamber between a localized mid infundibular stenosis and a dome stenosis of the pulmonic valve. The aorta failed to opacify.

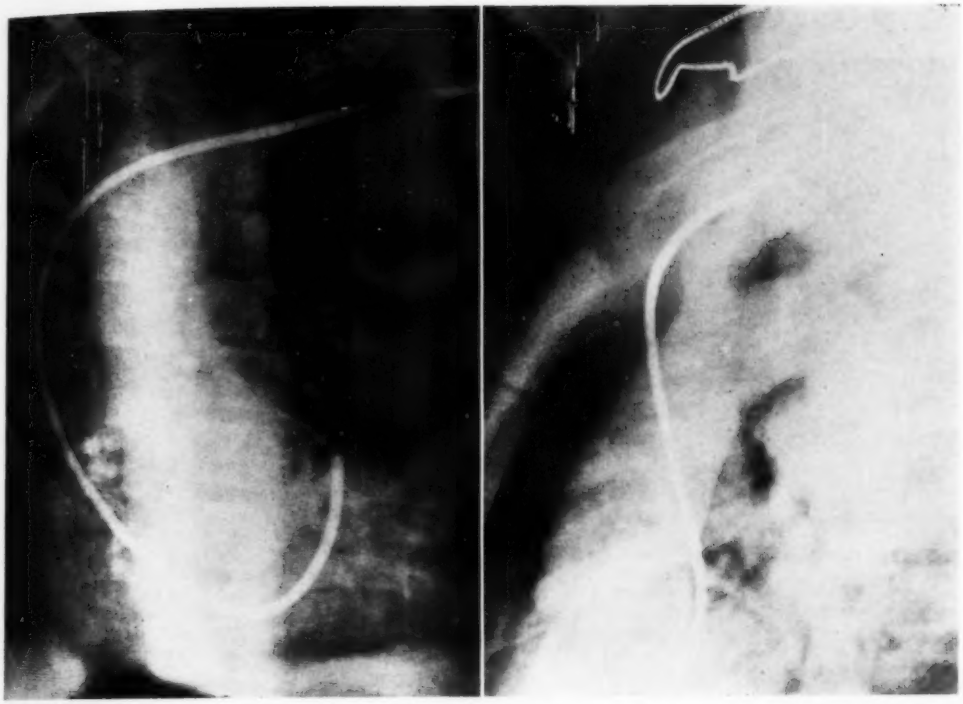

Fig. 4. Tetralogy of Fallot in a 10-year-old boy with extreme cyanosis, clubbing, and squatting. There was a soft, continuous murmur over the upper chest. Cardiac catheterization pressures: aorta 90/55; right ventricle 100/5; the pulmonary artery was not entered. Selective angiocardiography with the catheter in the outflow tract of the right ventricle demonstrated massive filling of the markedly dextroposed aorta, right aortic arch, and right descending aorta. The pulmonary arteries were not demonstrated. Large bronchial arteries arise from the descending aorta.

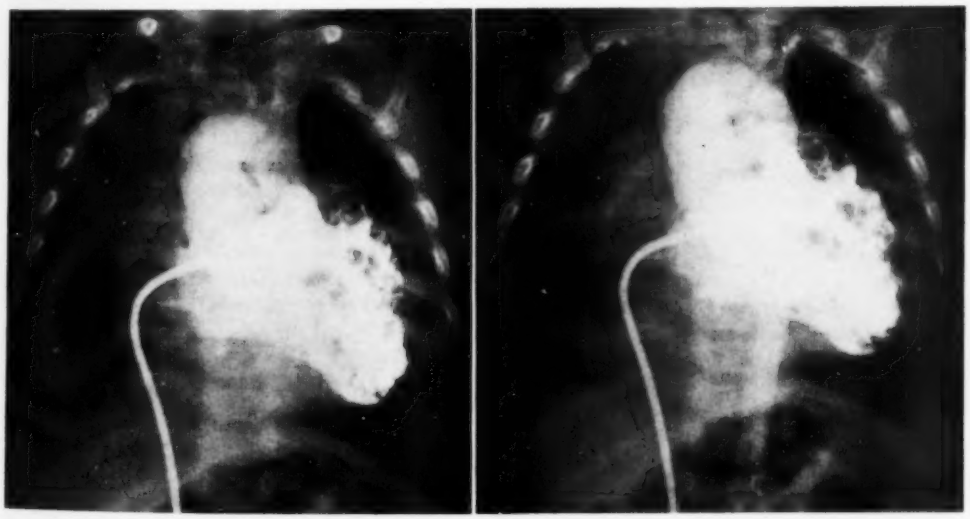

Fig. 5. Tetralogy of Fallot in a 3-month-old boy with extreme cyanosis and dyspnea but no cardiac murmur. Cardiac catheterization pressures: systemic artery 90/65; right ventricle 125/10. Aorta and pulmonary artery not entered. Selective angiocardiography with the catheter in the mid right ventricle showed (*a*) wide filling of the infundibulum terminating at an atretic pulmonic valve; (*b*) a large overriding aorta; (*c*) small pulmonary arteries filling from the aortic arch through a patent ductus arteriosus. The autopsy findings were pulmonary valvular atresia, patent ductus arteriosus, ventricular septal defect, and dextroposition of the aorta.

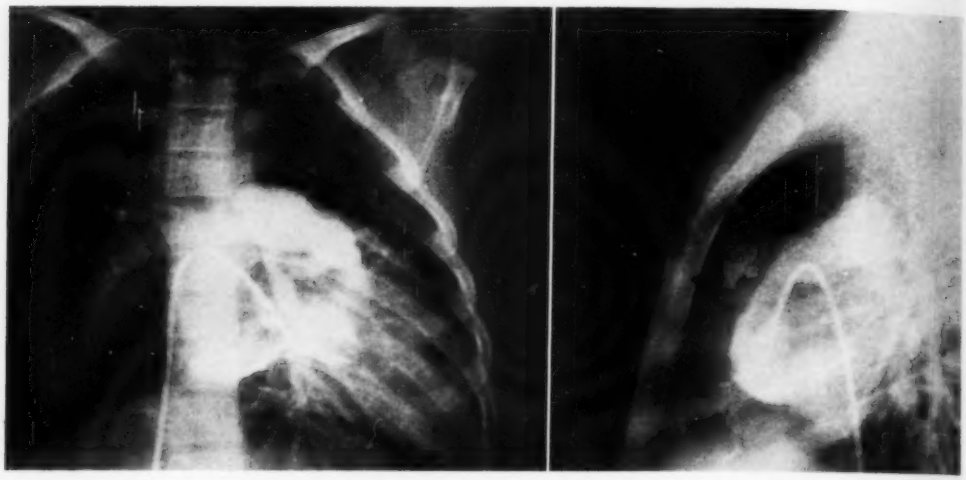

Fig. 6. Pulmonic stenosis with a normal aortic root in an 8-year-old girl. The clinical findings of severe valvular stenosis were typical, except for a bizarre cardiac configuration. Cardiac catheterization showed valvular pulmonic stenosis. Pressure in pulmonary artery 15/0; right ventricle 150/5. The site of a small auricular right-to-left shunt was proved by reduced oxygen saturation of left auricle blood (91 per cent). Selective angiocardiography with the catheter in the tricuspid region showed (*a*) right auricle reflux; (*b*) dome stenosis of pulmonic valve; (*c*) poststenotic dilatation of the pulmonary artery trunk. At operation (valvulotomy) congenital absence of the pericardial sac was found.

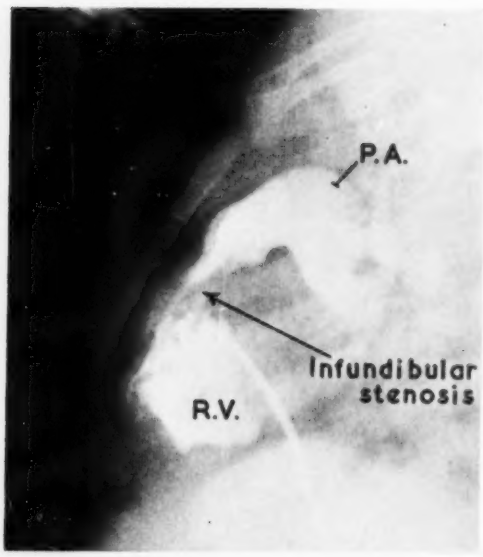

Fig. 7. Pulmonic stenosis with a normal aortic root in a 2-year-old non-cyanotic boy, with a harsh systolic murmur in the third and fourth left interspaces. Cardiac catheterization pressures: pulmonary artery 25/5; infundibulum 25/5; inflow tract of right ventricle 60/0; systemic artery 105/55. An associated left-to-right auricular shunt was detected by sampling and indicator dilution study. Selective angiocardiography from the mid right ventricle demonstrated (*a*) tubular mid-infundibular stenosis through which a jet of contrast material passed to the normal pulmonary valve; (*b*) the auricles, as well as (*d*) progressive dilution of the contrast medium in its course from the right auricle. It is perfectly true, as Lind and his associates (7) point out, that selective angiocardiography from the right ventricle excludes information about auricular defects. However, probing for the foramen ovale in the preliminary catheterization and confirmation of the site of venoarterial shunt by selective ether test (8) and/or selective T-1824 studies (9) compensate for this deficiency. After the catheter has been carefully withdrawn from the pulmonary artery for a record of the pressure gradient, the tip is placed for injection near the apex but not against the wall of the right ventricle.

With the catheter in this position, the outflow tract is clearly defined. All varieties of obstruction in this region can be shown. Figure 1 illustrates valvular, Figure 2 infundibular, and Figure 3 combined stenosis. Occasionally jets are demonstrated (Fig. 1). A variation of caliber of

poststenotic dilatation of the pulmonary artery, especially of the left branch. Subsequent films confirmed the auricular left-to-right shunt and showed the cyclic variation of the caliber of the infundibulum.

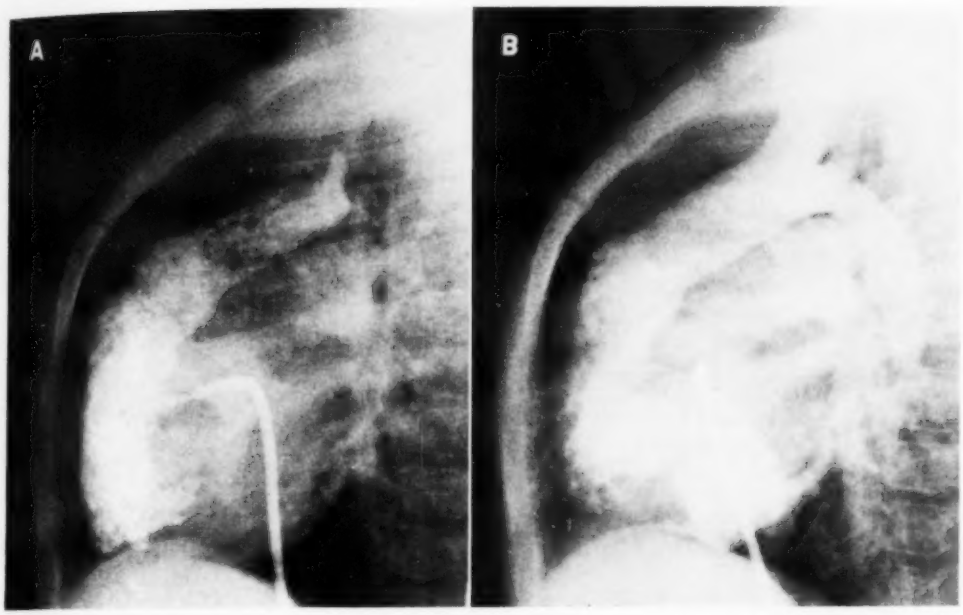

Fig. 8. Taussig-Bing malformation in a 3-year-old boy with moderate cyanosis and clubbing, but no cardiac murmur. Cardiac catheterization showed that both the aorta and pulmonary artery entered from the right ventricle. The left heart was catheterized *via* the auricular defect. Pressure in the right ventricle 100/10; pulmonary artery 100/65; aorta 100/65; left ventricle 100/10. Selective angiocardiography was done from the right ventricle.

A. Lateral view at commencement of ventricular systole. Diodrast fills the right ventricle and escapes both into the transposed aorta and through an interventricular defect (12 mm. in diameter) into the left ventricle.

B. Lateral view in late ventricular systole. The aorta is now well defined and the large, incompletely transposed pulmonary artery fills less clearly.

the infundibulum during the cardiac cycle is frequently revealed. The size of the pulmonary artery and its branches is clearly shown. Only in the presence of pulmonary atresia does selective injection from the right ventricle fail to opacify the pulmonary arteries.

The aorta may fail to fill with Diodrast if the catheter has been placed in the outflow tract or in instances of minimal aortic overriding. Thus, absence of aortic opacification does not necessarily indicate a nor-

Fig. 9. Single ventricle with complete transposition of the great vessels in a 3-month-old boy cyanosed from birth. In cardiac catheterization the catheter entered the ventricular chamber from both auricles. Pressures: ventricle 70/10 (in both entries); pulmonary artery 65/25. Selective angiocardiography done from the posterior portion of the common ventricle shows immediate filling of the entire ventricular portion of the heart and the transposed great vessels. The clear area below and central to the valve rings is the crista supraventricularis separating the larger pulmonary outflow tract from the smaller systemic outflow tract.

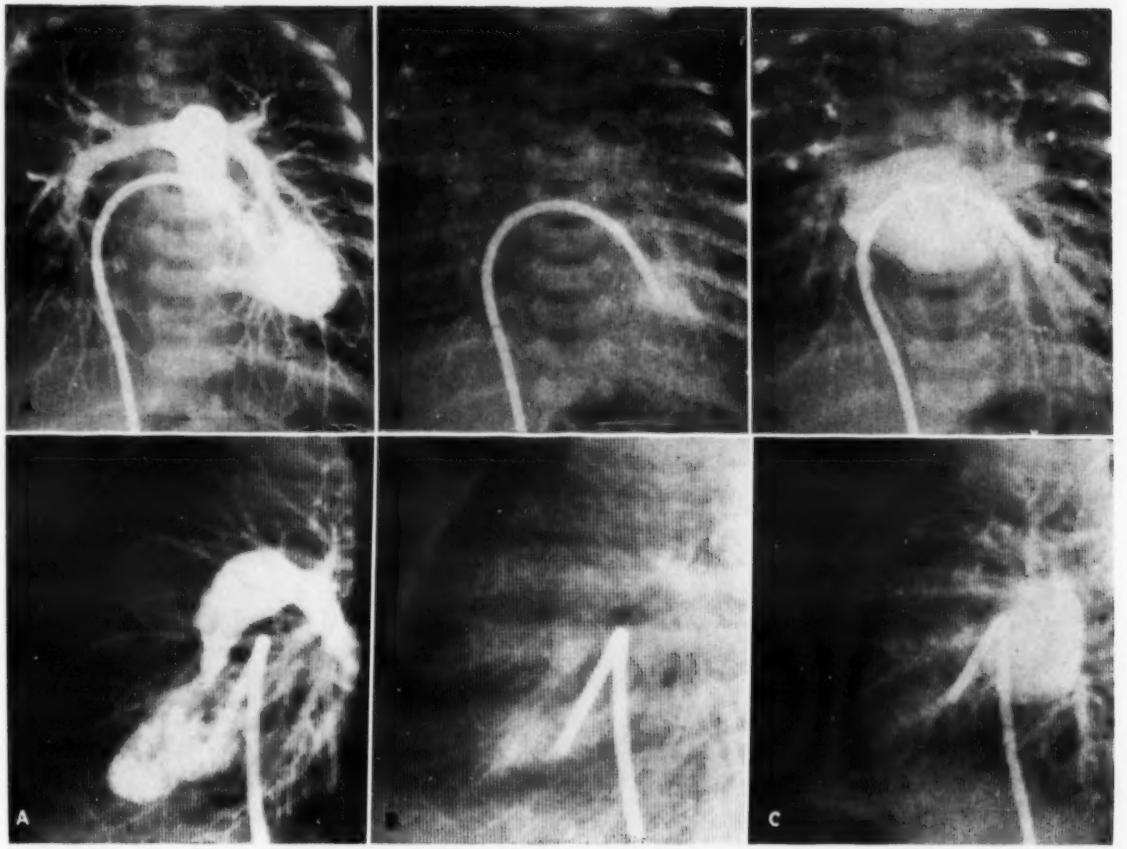

Fig. 10, A–C. Complete transposition of the great vessels in a 6-week-old boy with marked cyanosis and congestive heart failure. Cardiac catheterization pressures: right ventricle 55/5 (O_2 saturation 41 per cent); left ventricle 40/0; left auricle 4; right auricle 5. Selective angiocardiography was done from the left ventricle.

A. Early ventricular diastole. Contrast material in pulmonary artery and branches; pulmonary valve closed; left ventricle filling with Diodrast *via* cardiac catheter. The main pulmonary artery does not contribute to the narrow supracardiac pedicle or the left cardiac border. Note the posterior and medial position of this vessel.

B. Complete dispersion of contrast material within the lungs.

C. Opacification of pulmonary veins and large left auricle in diastole. For D and E, see opposite page.

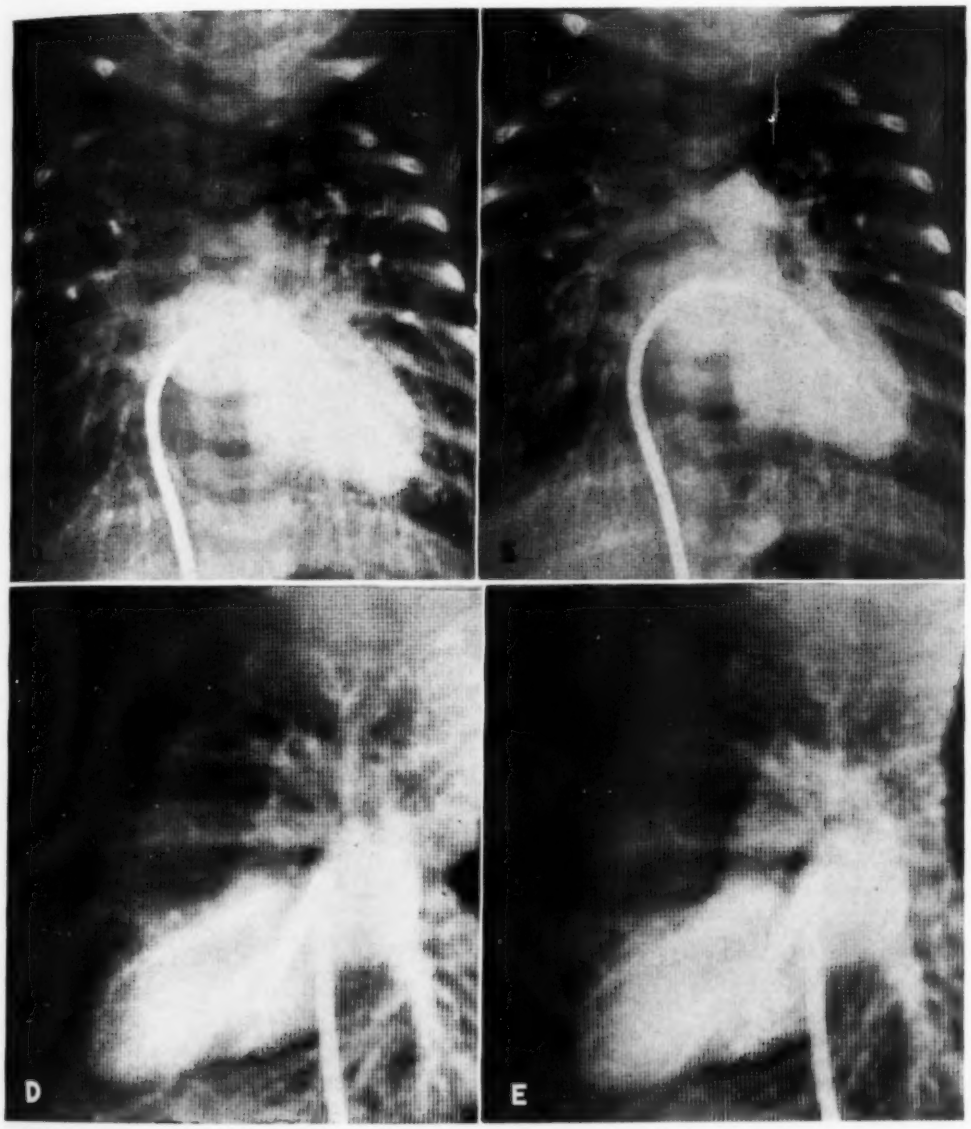

Fig. 10, D and E.

D. Auricular systole with accompanying left ventricle filling.

E. Reopacification of pulmonary circuit. No demonstrable amount of Diodrast has escaped from the left to the right heart or aorta.

filling with Diodrast *via* cardiac catheter. The main pulmonary artery does not contribute to the narrow supracardiac pedicle or the left cardiac border. Note the posterior and medial position of this vessel.

B. Complete dispersion of contrast material within the lungs.

C. Opacification of pulmonary veins and large left auricle in diastole. For D and E, see opposite page.

mal aortic root, and other methods may be required to demonstrate veno-arterial shunts. With considerable overriding of the ventricular septum, the aortic origin is well defined and the upper margin of the ventricular septum may be visualized, particularly in the lateral view.

The collateral lung circulation, either bronchial (Fig. 4) or ductal (Fig. 5), in cases with severe pulmonic stenosis or atresia is particularly well shown in the lateral projection. The advantages provided the cardiac surgeon by such studies are obvious.

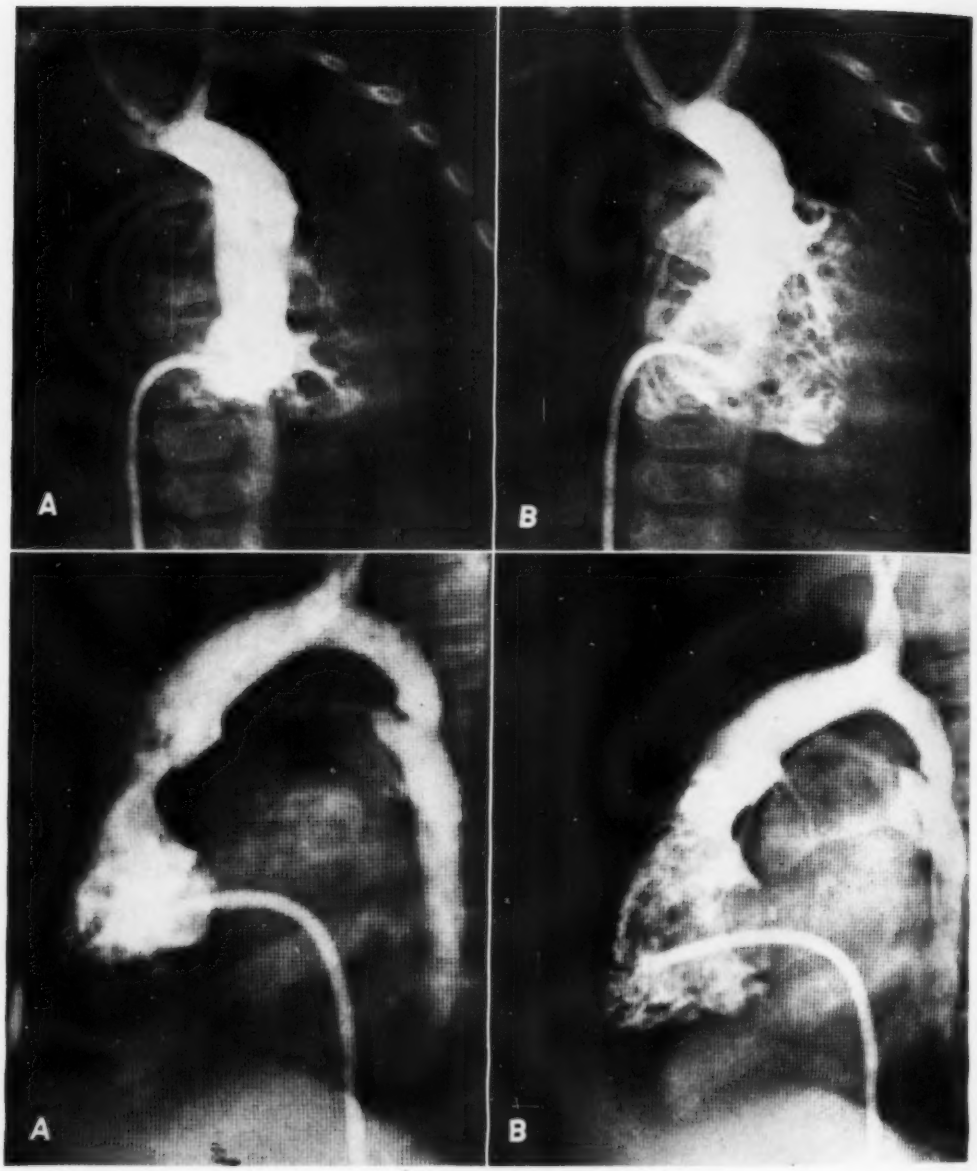

Fig. 11. Complete transposition of the great vessels with coarctation of the aorta in a 7-month-old girl with moderate cyanosis. The blood pressure (cuff), arm and leg, was 70/50 mm. Hg. On cardiac catheterization the pulmonary artery was not entered. Pressure in right ventricle 75/5; aorta 75/45. Selective angiocardiography performed from the right ventricle shows:

A. In ventricular systole. Immediate filling of the right ventricle, aorta, and aortic branches. There is a mild degree of preductal coarctation visible in the lateral film with commencing retrograde filling of the transposed pulmonary artery through a narrowly patent ductus arteriosus. A small left-to-right shunt between the ventricles is also visible in this view.

B. The size of the transposed pulmonary artery as well as coronary artery filling is better seen during early ventricular diastole. Note the change in caliber of the outflow tract of the right ventricle in systole and diastole.

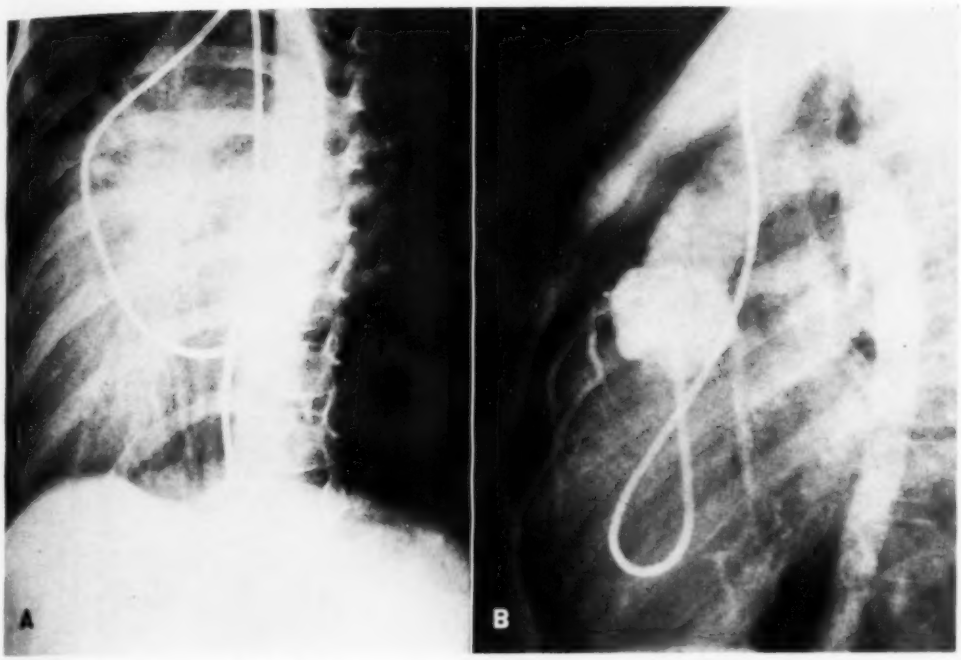

Fig. 12. Complete transposition of the great vessels in a 7-year-old girl with dyspnea and cyanosis on effort, slight cardiac enlargement, pulmonary hypertension, and marked right ventricle hypertrophy. The clinical diagnosis was reverse ductus arteriosus. Cardiac catheterization pressures: right ventricle 110/5; descending aorta 110/50.

A. Lateral view with catheter tip in descending aorta after traversing the superior vena cava, right auricle, and outflow tract of the right ventricle. The course of the catheter is not unlike that seen when a patent ductus arteriosus is probed from the pulmonary artery.

B. Selective angiocardiography done from the aortic root demonstrates complete transposition of the aorta. Note coronary arterial filling and distention of the aortic sinuses.

Pulmonary Stenosis with Normal Aortic Root: On the whole, this simpler malformation is better studied by cardiac catheterization, which is the standard investigation for the condition. Figure 6 shows the result of selective injection from the right ventricle in a patient who had severe dome-type valvular stenosis (right ventricular pressure 150/5 mm. Hg). In cases of infundibular stenosis, selective angiocardiography added to the catheter study may give more precise information about the level and nature of the stenosis (Fig. 7).

Transposition of the Great Vessels: The majority of our patients with transposition of the great vessels are very young infants (10), so that venous angiocardiography is a satisfactory method of confirming the diagnosis. For variants such as the Taussig-Bing anomaly (Fig. 8), single ventricle (Fig. 9), or other complicated cases (Fig. 11) the selective injection is preferred. As a method of determining the shunt pattern in the uncomplicated cases, we are at present performing selective studies from the left ventricle. The left heart is entered easily from the right auricle *via* the foramen ovale, which is almost always patent in these infants. Figure 10 demonstrates the sequence of left heart circulation in one such case. In older children with complete transposition of the great vessels, where the clinical picture is less characteristic, selective angiocardiography may save embarrassing errors of interpretation at the time of cardiac catheterization. One patient, a seven-year-old girl with very slight cyanosis, was thought to have either Eisenmenger's complex or ductus arteriosus with reversal of flow. At car-

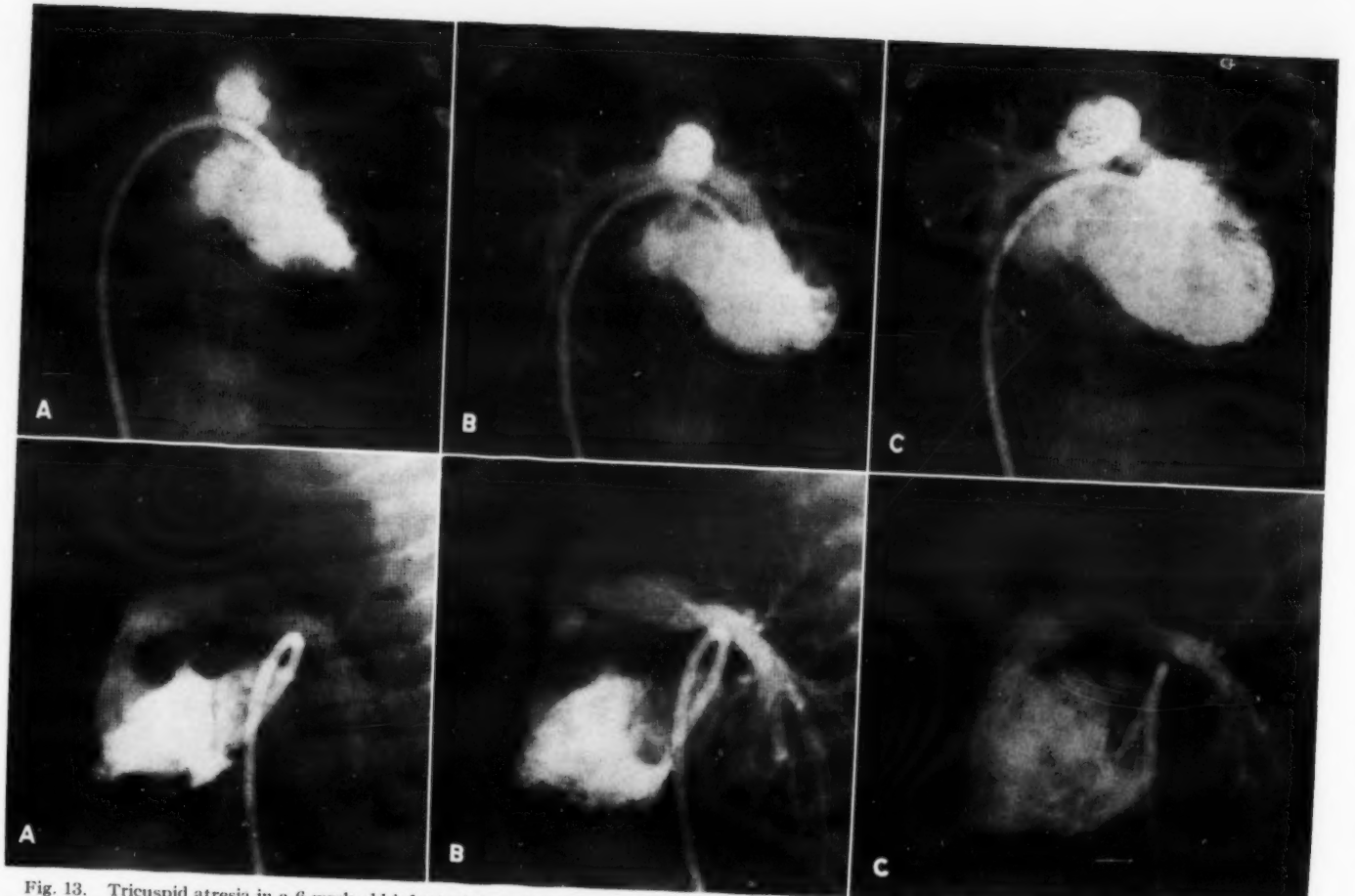

Fig. 13. Tricuspid atresia in a 6-week-old infant with moderate cyanosis, a harsh systolic murmur with thrill over the lower chest, and slight cardiac enlargement. The electrocardiogram showed left axis deviation and left ventricular hypertrophy. The left heart was catheterized *via* the patent foramen ovale. Selective angiocardiography was done from the left ventricle.

A, B, and C. Ventricular diastole. The right ventricle and pulmonary artery fill during this phase of the cardiac cycle. The right ventricle appears as a right anterior appendix of the left ventricle. The subpulmonary portion of the right ventricle is maximally dilated in late ventricular diastole (C). See following page for ventricular systole.

diac catheterization the catheter passed from the outflow tract of the right ventricle into the descending aorta. Selective injection from the valve region showed this vessel to be a transposed aorta rather than a pulmonary artery (Fig. 12).

Tricuspid Atresia: Venous angiocardiography in small infants usually assists in confirming the diagnosis of tricuspid atresia. Anatomical detail of the right ventricle, however, is not always disclosed by that method. Through a selective technic, evidence may be obtained from the left ventricle of the anatomical type of malformation and, in particular, the size and level of the interventricular defect, the size of the rudimentary chamber, and the presence or absence within it of subvalvular stenosis, as well as the great vessel arrangement. The advantage of excluding the large auricular opacification is evident (Fig. 13).

Single Ventricle: It is often impossible to decide by means of standard venous angiograms whether the ventricular portion of the heart is formed by a single chamber. Superimposition of auricular shadows or right-to-left shunts frequently causes difficulties of interpretation. Intraventricular injection of Diodrast is followed by immediate global filling in cases with a single ventricle (Fig. 9).

Ventricular Septal Defect: Most authors have reported infrequent success in the use of angiocardiography to demonstrate an isolated interventricular communication. Recently Lind (5) obtained serial biplane angiocardiograms during the phases of the cardiac cycle and was able to indicate dilution of contrast medium in the right ventricle during ventricular systole in this malformation. Reopacification of the pulmonary artery is a further sign. Utilizing the selective technic in cases of isolated ventricular septal defect, it is possible to show the size and position of the defect directly when there is marked pulmonary and right heart hypertension (Fig. 14). In cases with slight or no change in the right ventricular pressure the selective technic has no special advantage over the venous

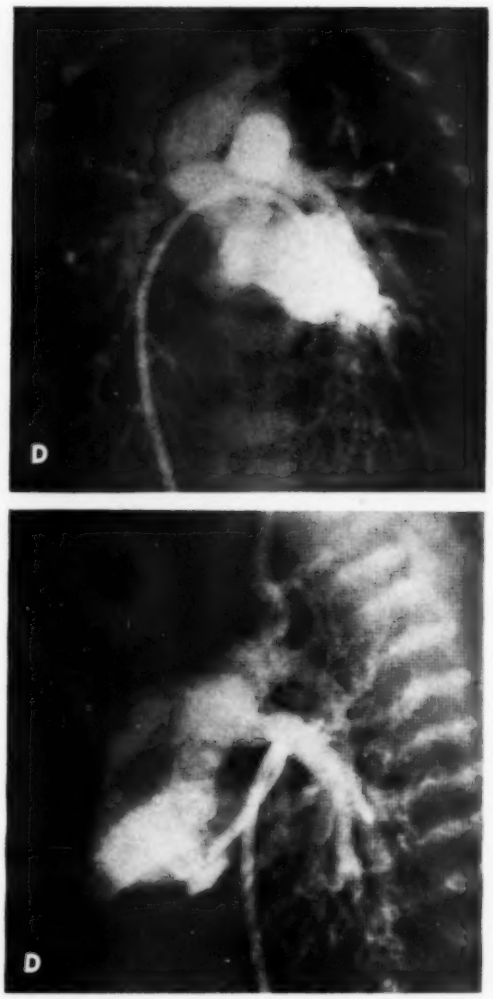

Fig. 13, D. Tricuspid atresia (see preceding page). Ventricular systole. Systolic opacification of the normally situated aorta and contraction of the right ventricle infundibulum—dynamic stenosis.

route other than the elimination of superimposed auricular shadows (Fig. 15).

Auricular Septal Defect: Study of the size and position of isolated auricular septal defects by selective injection from the left auricle has proved satisfactory (11). We have used this technic in 2 infants with auricular septal defect and in 1 with atrioventricularis communis (Fig. 16).

Anomalous Pulmonary Venous Drainage: Where total anomalous pulmonary venous drainage is suspected at cardiac catheteri-

enlargement. The electrocardiogram showed left axis deviation and left ventricular hypertrophy. The left heart was catheterized *via* the patent foramen ovale. Selective angiocardiography was done from the left ventricle.
A, B, and C. Ventricular diastole. The right ventricle and pulmonary artery fill during this phase of the cardiac cycle. The right ventricle appears as a right anterior appendix of the left ventricle. The subpulmonary portion of the right ventricle is maximally dilated in late ventricular diastole (C). See following page for ventricular systole.

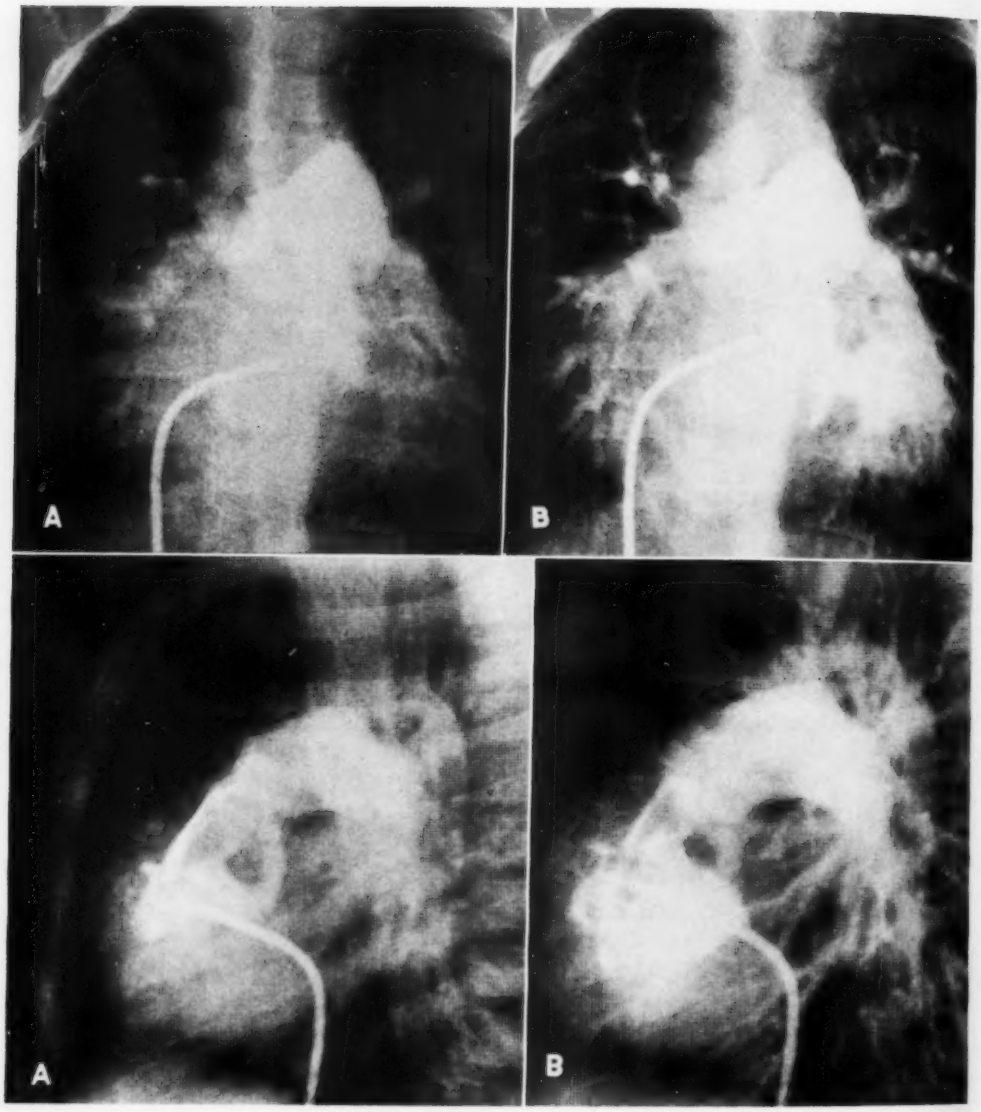

Fig. 14. Ventricular septal defect in a poorly developed 7-month-old boy, with moderate cyanosis, right ventricle hypertrophy, and cardiac enlargement with pulmonary plethora. Cardiac catheterization pressures: right ventricle 80/5; pulmonary artery 80/55. The site of the right-to-left shunt was confirmed by indicator dilution curves, which also revealed a large left-to-right shunt. Selective angiocardiography done from mid right ventricle. Anteroposterior and lateral films show:

A. Diodrast passing, at the start of ventricular systole, from the right ventricle to the pulmonary artery and through a ventricular septal defect, approximately 5 mm. in diameter, toward the aortic root in the left ventricle outflow tract.

B. During maximal ventricular systole, the continued ejection fills both the large pulmonary artery and branches and aorta. There is no aortic overriding. The right-to-left flow through the ventricular defect is especially clear in the frontal view.

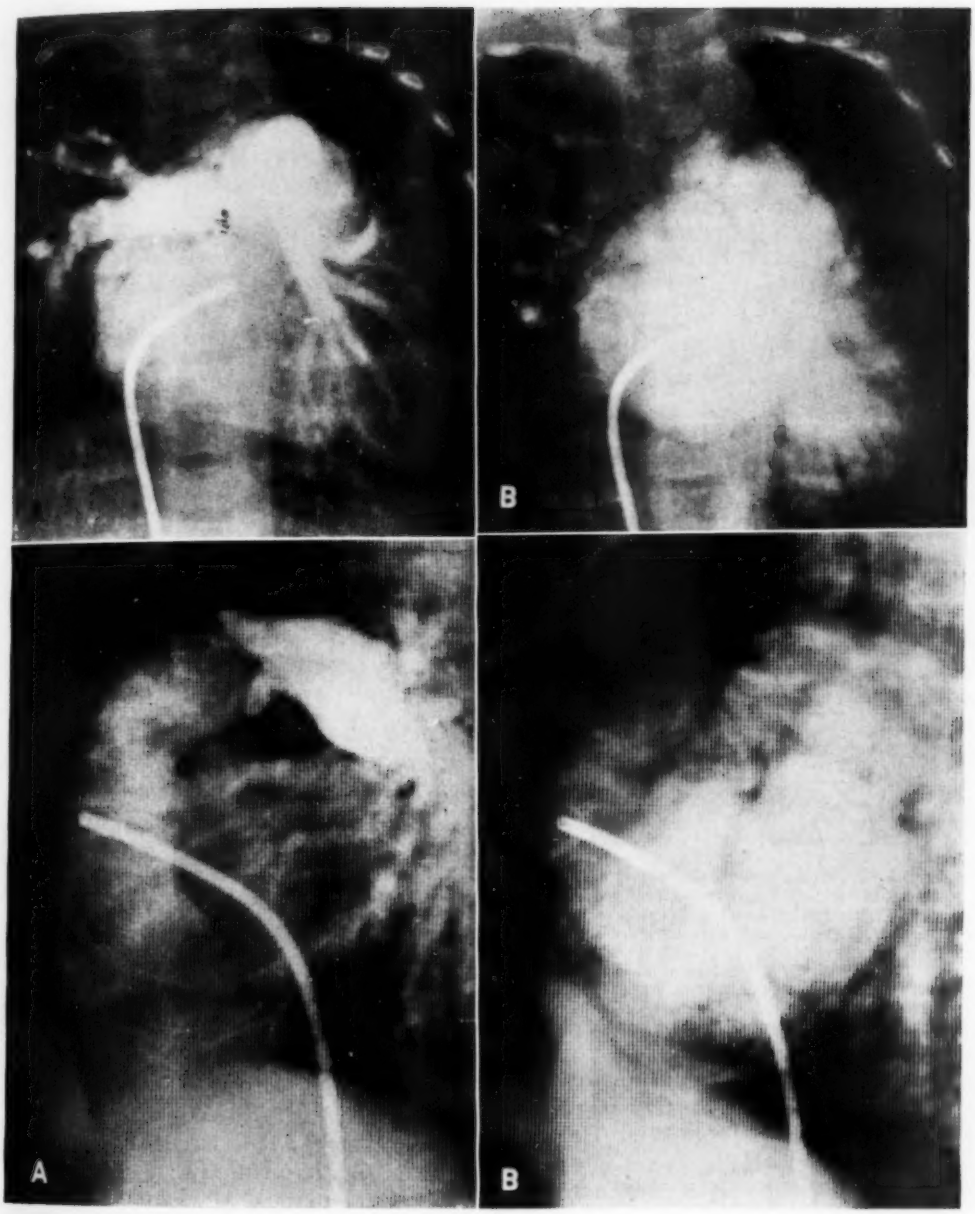

Fig. 15. Ventricular septal defect in a 9-month-old non-cyanotic boy who failed to thrive and suffered frequent respiratory infections. Cardiac catheterization showed a large volume left-to-right shunt between ventricles, with no right-to-left shunt. Pressures: right ventricle 60/0; pulmonary artery 50/15; systemic artery 120/75. Selective angiocardiography done from the right ventricle. Anteroposterior and lateral views, showed:

A. Dilution of contrast medium in right ventricle but not in pulmonary artery at the end of ventricular systole.

B. Later sequence in ventricular systole, illustrating a large left auricle, a normally situated aorta, and re-opacification of right ventricle and pulmonary artery. In the one and one-half seconds (13 films) between A and B, Diodrast disappeared progressively from the pulmonary artery.

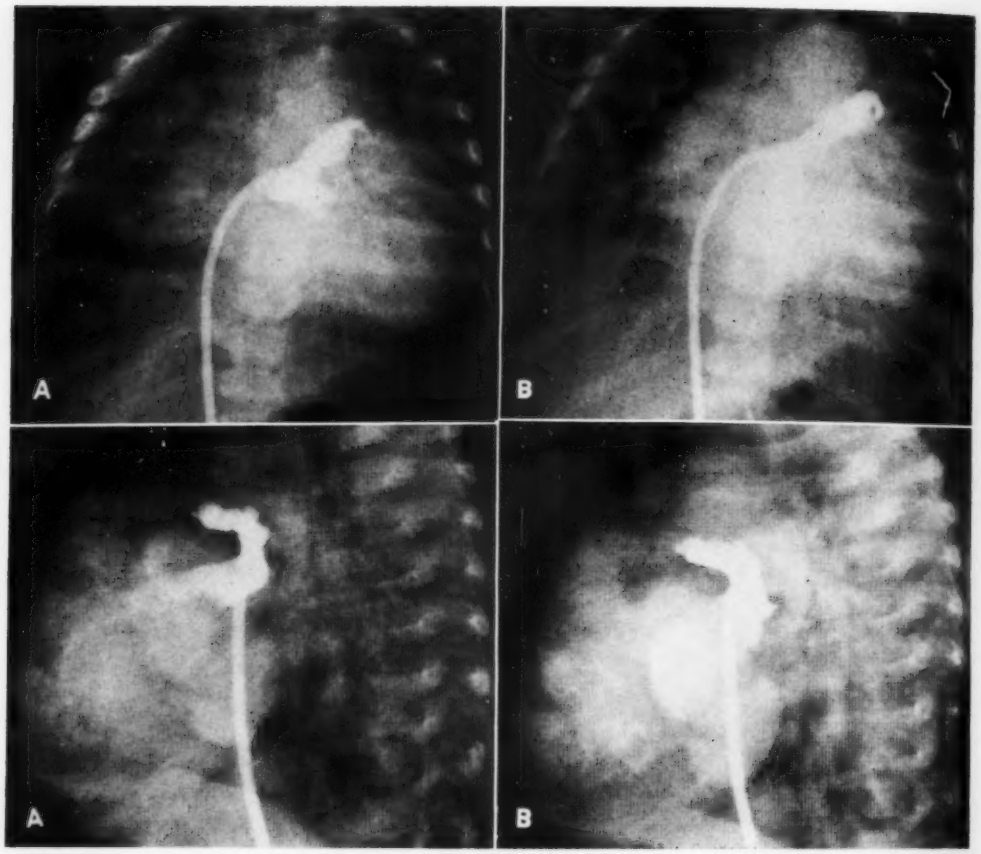

Fig. 16. Atrioventricularis communis in a 5-month-old infant with slight cyanosis and marked dystrophy. Cardiac catheterization revealed a large volume left-to-right shunt at the auricular level. The right ventricle was not entered, but the left heart was readily catheterized *via* the auricular defect. The blood of the left ventricle was desaturated. Selective angiocardiography was performed from the left auricle. Anteroposterior and lateral views, showed:

A. The left auricle appendage is filled. Diodrast passes in a 7-mm. stream into the right ventricle and, more diffusely, into the left ventricle.

B. Pulmonary artery and aortic filling during ventricular systole

At autopsy, the findings were persistent atrioventricularis communis plus high auricular septal defect.

zation, selective injection of contrast material into the pulmonary artery reveals the abnormal pathways (Fig. 17). The technic should be especially useful in the uncommon types with connections to the right auricle, ductus venosus, or portal vein.

Other Conditions: The clarity obtained with selective injection from a normal left ventricle is shown in Figure 18. This result suggests that the route might be valuable in cases of *aortic or subaortic stenosis* in young children, when a patent foramen ovale permits entry to that side.

COMMENT

It is not intended to suggest, because of the advantages of selective over venous angiography in certain circumstances, that the former method is not valuable. On the contrary, the venous route is particularly helpful in small cyanotic infants where the range of diagnostic possibilities is wider than at any other time. Intelligent use of the selective technic implies knowledge beforehand of the particular malformation. Its value lies in making refinement of diagnosis possible rather than

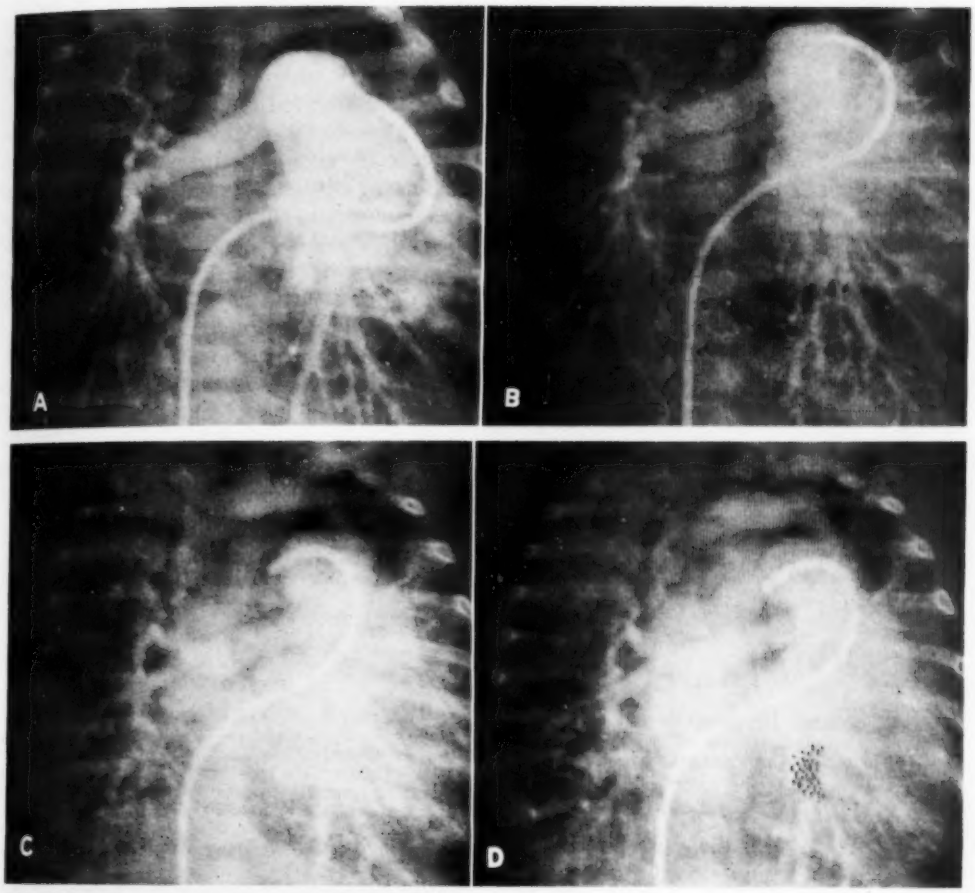

Fig. 17. Complete anomalous pulmonary venous drainage in a 2-month-old boy with dyspnea and cyanosis from birth. Cardiac catheterization showed oxygen saturations as follows: left innominate vein 90 per cent; superior vena cava 79 per cent; right auricle 77 per cent; right ventricle 75 per cent; systemic artery 69 per cent. Pressures: right ventricle 95/15; pulmonary artery 95/40; systemic artery 65/60. Selective angiocardiography done from the bifurcation of the main pulmonary artery (anteroposterior views) showed, in sequence: filling of the pulmonary arteries, commencing pulmonary venous return (better visualized on right side), drainage of pulmonary veins into the left superior vena cava, the left innominate vein, and right auricle. From here, there is recirculation to the lung and some shunting to the left auricle, left ventricle, and aorta. The left superior vena cava is unusually small. Autopsy findings were total anomalous pulmonary venous drainage (into persistent left superior vena cava), and patent foramen ovale.

Fig. 18. Normal left cardiac chambers and aorta. Inadvertent injection of contrast material from the left ventricle in a case of primary pulmonary hypertension with patent foramen ovale. The catheter has flipped back into the left auricle.

in arriving at the diagnosis itself. The importance of apparent minutiae in anatomy and hemodynamics has already been demonstrated in the tetralogy of Fallot when direct surgery is contemplated. Other cardiac malformations are becoming more important from this point of view with the development of surgical measures which may lead to correction of a number of conditions presently regarded as hopeless.

SUMMARY

The method of selective angiocardiography originally described by Jönsson for use in older children and adults has been applied to infants and young children.

In a limited experience with 50 cases the technic has been found particularly valuable in studying anatomical and hemodynamic details not always revealed by the classical venous procedure.

Selective angiograms of patients with tetralogy of Fallot, pulmonary stenosis with normal aortic root, transposition of the great vessels, tricuspid atresia, single ventricle, isolated ventricular septal defect, auricular septal defect, and anomalous pulmonary venous drainage are reproduced.

The relative merits of venous and selective technics in this age group are discussed briefly. It is concluded that the venous angiogram is especially helpful in very small infants with cyanotic heart disease and that the selective method is of greatest value where the broad anatomy of the defect is suspected prior to the study but where particularly clear visualization of a certain area is required.

ADDENDUM: In a further 80 selective angiocardiograms obtained since submission of this paper there has been one avoidable fatality. Certain aspects of the added experience will be the subject of a later communication.

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SUMARIO

La Angiocardiografía Selectiva en Lactantes y Niños Mayores

El método de angiocardiografía selectiva, descrito primitivamente por Jönsson para aplicación en niños mayores y personas adultas ha sido ahora aplicado a lactantes y niños pequeños. En una observación limitada en 50 casos, la técnica ha resultado en particular valiosa para el estudio de pormenores anatómicos y hemodinámicos que no revela siempre la clásica técnica venosa.

Reprodúcense angiogramas selectivos de enfermos que padecían de tetralogía de Fallot, estenosis pulmonar con raíz aórtica normal, transposición de los grandes vasos, atresia tricuspidiana, ventrículo único, malformación aislada del tabique ventricular, malformación del tabique auricular y anomalía del drenaje venoso pulmonar.

Discútense brevemente los relativos méritos de las técnicas venosa y selectiva en este grupo de edad. Dedúcese que el angiograma venoso resulta útil especialmente en los lactantes muy pequeños que padecen de cianosis cardíaca y que el método selectivo alcanza su mayor valor cuando se sospecha toscamente la anatomía de la malformación antes de estudiarla y se requiere una visualización en particular clara de cierta zona.

Applications of the Mayneord Contour Projector to Various Dosage Problems in Radiotherapy[1]

VICTORIA CASTRO, B.A., CHARLES SOIFER, B.A., and EDITH H. QUIMBY, Sc.D.

THE MAYNEORD contour projector (1) is a useful instrument in a variety of three-dimensional dosage problems. Such information as has been published concerning it deals only with symmetrical circular beams. A slight adaptation, which extends its application to rectangular fields and wedge filters, considerably increases its usefulness.

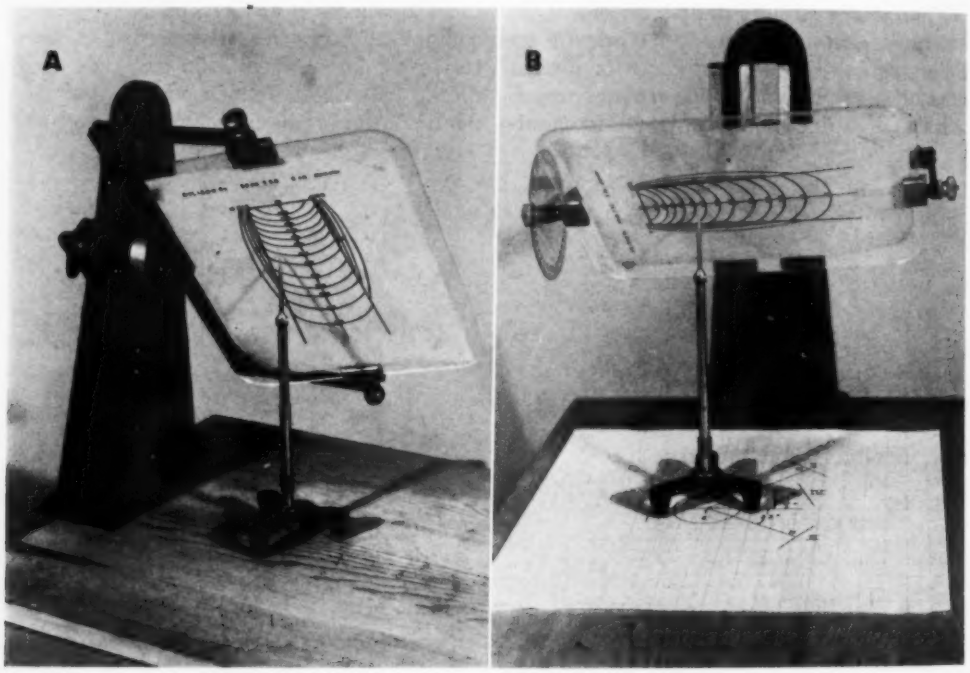

Fig. 1. The Mayneord contour projector. A. Original model. B. With added circular protractor.

DESCRIPTION

Photographs of the apparatus are shown in Figure 1. Its use with beams of circular cross section depends upon the fact that the isodose distribution is symmetrical about the central axis. Thus, distribution of radiation in any plane perpendicular to the axis will be in concentric circles, as shown in Figure 2. Doses in any plane other than the one through the axis might be determined if the intersection of this plane with the circles could be found. Intersections of such a plane, CCC′C′, with three levels of isodose circles, are indicated in Figure 2. These points of intersection can be established with the contour projector.

The movable steel pointer on the tripod base in the photograph is used to simulate a plane in space, parallel to the drawing

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board on which it rests. As the tripod is moved about on this board, the tip of the pointer is always in a plane parallel to it and at a fixed height above it. The height of the pointer is adjustable. Its base contains a pencil or other marking device.

If the Lucite plate carrying the isodose chart is horizontal and the pointer tip is adjusted to the same height as the plate, then, as the pointer follows a particular isodose line, the marker will transfer this line to a paper at the base. If, however, the pointer tip is placed at a fixed distance, for example 2 cm., below the horizontal plane, the plate will have to rotate until contact is established, as in Figure 1B. This contact is at the point of intersection of the plane indicated by the tip of the pointer and the isodose circle 2 cm. out from the axis. Thus the dose has been found at a particular point 2 cm. from the plane of the isodose chart. Details are given in the original paper (1) for various uses of the instrument with a circular beam. For the benefit of those who do not have easy access to the British literature, some of these uses are reviewed in an Appendix to the present paper.

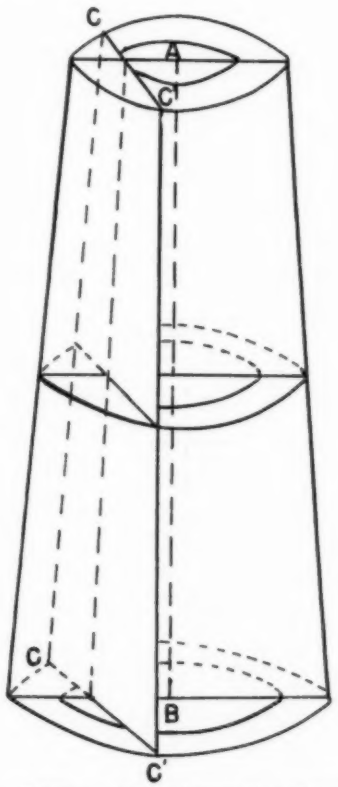

Fig. 2. Diagram showing intersection of any plane (CCC'C') with circular x-ray beam.

APPLICATION TO RECTANGULAR FIELDS

For rectangular fields there is no symmetrical distribution of radiation about a central axis. Isodose charts usually are obtained in the planes of the long and short axes; outside these planes direct determination of dose has not generally been practicable. If, however, in addition to the two isodose charts in the planes of the long and short axes, a third is obtained in a diagonal plane, the contour projector can be adapted for dosage determinations at all off-axis points. This adaptation will also permit dose-finding with wedge filters. It is for this purpose that the circular protractor at the top of the plate support (Fig. 1B) is employed. This feature has been added to Mayneord's original design.

With circular beams, the angle through which the plate is turned to make contact with the pointer is of no importance. With a rectangular field, on the other hand, this angle becomes significant. Consider the plate placed in the plane of the long axis of the beam. If the pointer makes contact with no rotation of the plate, the point in question lies in the isodose chart through this long axis. If the plate must be rotated through 90° to establish contact, the point lies in the isodose chart through the short axis. At an intermediate angle (45° for a square; specific angles for other rectangles), the point lies in the chart through the diagonal. Knowledge of the angle of rotation of the plate makes it possible to select the appropriate isodose chart or to interpolate between two of them. The three charts should be plotted on the same diagram, as in Figure 3; it is convenient to use different colors, or types of lines, for the individual charts.

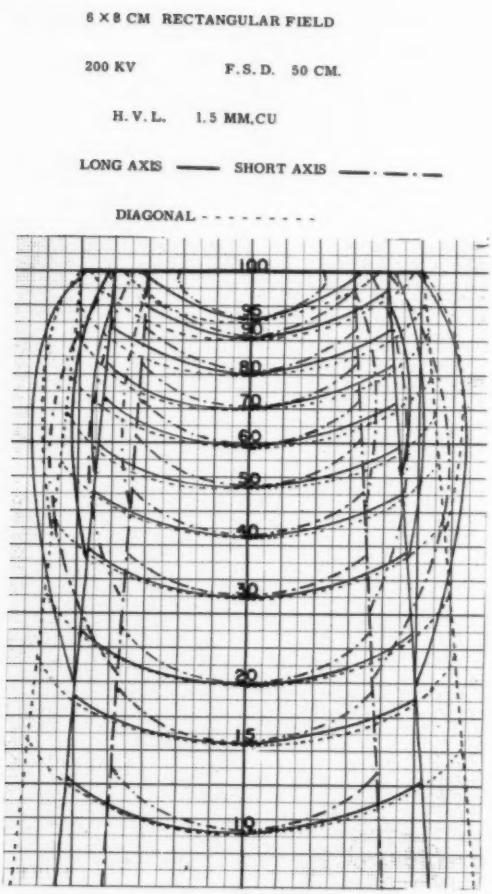

Fig. 3. Triple isodose chart for 6 × 8-cm. rectangular field. X-rays generated at 200 kv; h.v.l. 1.5 mm. Cu; F.S.D. 50 cm. Isodose charts in planes of short axis, long axis, and diagonal.

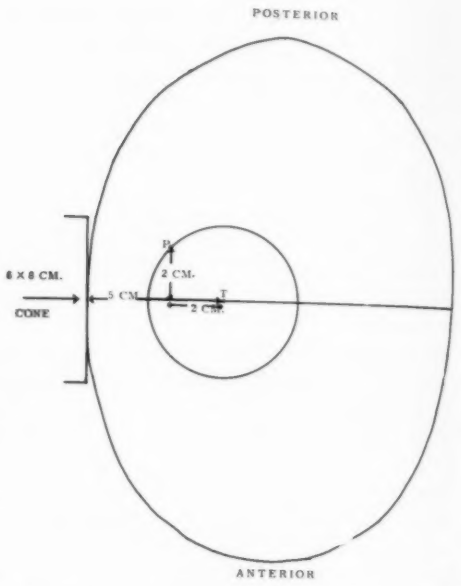

Fig. 4. Diagram for dose determination with rectangular field.

An example will illustrate the use of the dose finder with this type of chart. Consider a tumor of the position and dimensions shown in Figure 4; its central cross section in the horizontal plane is a 5-cm. circle, but its longitudinal extension is somewhat more than 5 cm. It is to be treated through a 6 × 8-cm. port, with the short axis horizontal and the long axis vertical with the patient in a sitting position. A sample point is P, 2 cm. closer to the skin than the tumor center, 2 cm. posterior, and 2 cm. below the plane of the chart.

The cross-section diagram is properly oriented on the base of the dose finder. The Lucite plate is parallel to the base (for a horizontal beam); the top edge of the isodose chart of Figure 3 is above the indicated port of entry, and the chart is centered. The tip of the pointer is set to touch the Lucite plate. Any point in the plane of the tip of the marker is now in the short-axis isodose chart. To find the dose for point P, which is in a plane 2 cm. *below* this, the Lucite plate must be moved *up* 2 cm. The base of the marker is then moved to the projection of point P, 2 cm. to the left of T and 2 cm. back. The plate is rotated until it makes contact with the marker, and the angle of rotation is read on the protractor at the end of the support. In this case it is 45°. For the 6 × 8-cm. field, with the 6-cm. axis at 0° and the 8-cm. axis at 90°, the diagonal will lie at 53° from the short axis. Hence, the point falls between the short axis and the diagonal, 45/53 of the angular distance from the short axis. The tip of the pointer reads 70 in the short axis isodose chart and 77 in the diagonal chart. Accordingly, the correct reading is 76. In other words.

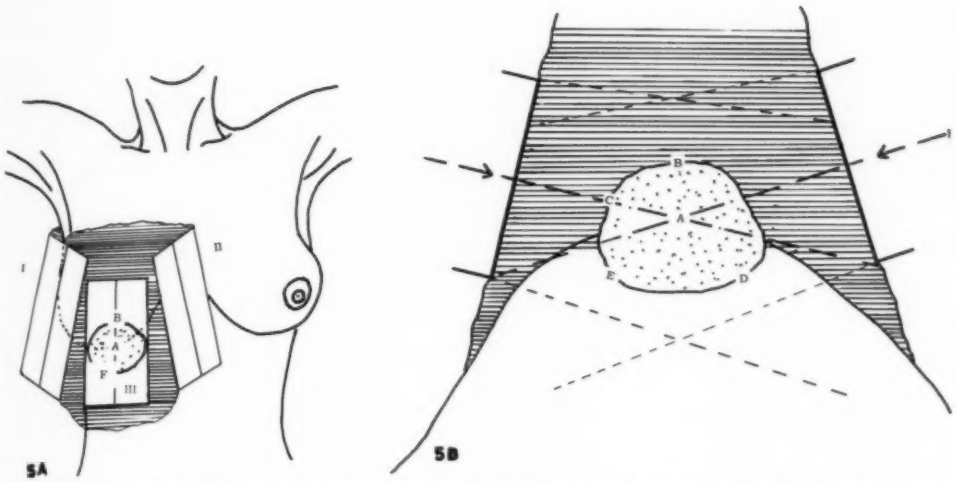

Fig. 5. Diagram illustrating "tangential" irradiation of cancer of breast, using breast box and bolus. Two lateral 10 × 15-cm. ports angled at 15° and one anterior 10 × 8-cm. port.

point P receives 76 r for each 100 r to the center of the skin field.

For any rectangle, the angles between long axis, diagonal, and short axis can be determined either by laying off the rectangle and measuring the angle with a protractor, or by simple trigonometric formulae. The angle between the long axis and the diagonal is

$$\tan^{-1}\frac{\text{short axis length}}{\text{long axis length}}.$$

The angle between the diagonal and the short axis is 90° minus the angle to the long axis.

Tilted beams can be used with rectangular fields in the same manner as with circular ones (see Appendix). The tilt of the beam is indicated on the circular scale on the support of the instrument, and the subsequent rotation of the plate on the protractor at the end of the plate axis.

The dose finder is particularly useful in such a situation as "tangential" irradiation of the breast, where the points of interest may not lie on the isodose charts for either the long or the short axis. The general problem is illustrated in Figure 5. Usually two rectangular fields are employed as shown, one lateral and one mesial; a direct anterior field frequently is added. In each, the long axis is generally parallel to the long axis of the body; the short axis lies in a sagittal section, which is the section of Figure 5B. The axes of the lateral and mesial beams may be parallel, or at a slight angle, as illustrated. A considerable part of each beam does not traverse tissue, but all the space within the beam is filled with bolus of tissue-equivalent material, so that standard isodose charts may be employed. Points of interest may lie in the plane of the short axis, or above or below it.

With the contour projector set up for Beam I, doses at any point in the plane of the short axis, such as A, D, E, can be read directly. For points toward the head (B), or feet (F), doses are found with the instrument positioned as just described for rectangular fields. After one beam is finished, the cross-section diagram is rotated through the correct angles for the other beams, and their contributions are found. If the axis of any beam is horizontal, but at a different level from that of Beam I, the Lucite plate must be moved up or down the correct distance. If any beam is at an angle to the horizontal, the plate must be tilted, as already explained.

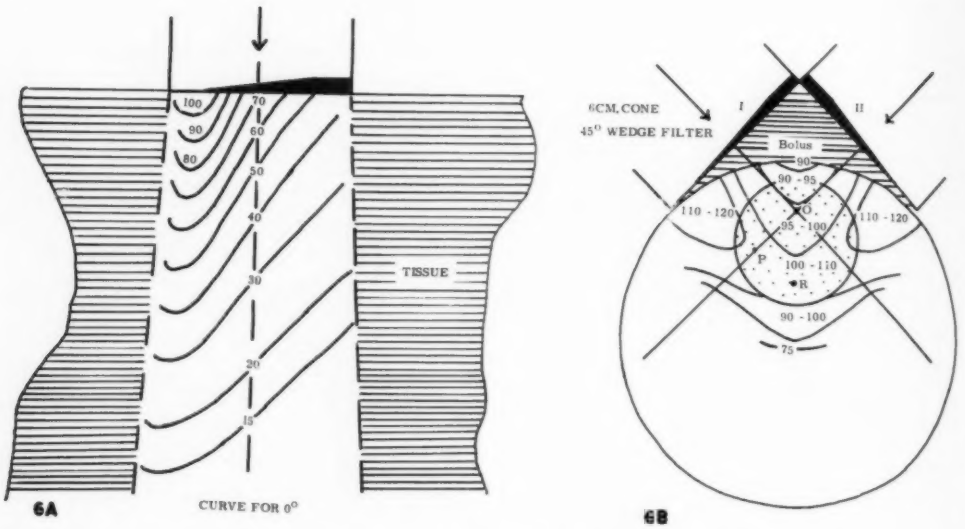

Fig. 6. Wedge filter. A. Isodose chart in plane of greatest distortion. B. Isodose curves for two wedge-filtered beams.

APPLICATION TO WEDGE FILTERS

When wedge filters are employed, the shape of the isodose chart changes continually with the angle between the plane of the chart and a particular reference plane through the wedge. In Figure 6A is shown an x-ray beam with a wedge filter; the axis of the beam passes through the center of the wedge. Isodose curves in a plane corresponding to the plane of the paper reveal the greatest distortion, as indicated; those in a plane perpendicular to this one are symmetrical about the axis, while those in intermediate planes show varying degrees of distortion. For dose finding with a wedge filter, four isodose charts are usually constructed: one in the plane of greatest effect, called the 0° plane; one at a right angle to this, the 90° plane; two in intermediate planes, usually at 30° and 60°. Figure 7 shows isodose charts for a 45° tilt wedge filter and a circular beam 6 cm. in diameter. Depth doses are given in per cent of the air dose at the center of the field, *without the wedge filter*.

Beams thus filtered are ordinarily used either in combination, as shown in Figure 6B, to provide uniform irradiation of an eccentrically situated tumor, or in horizontal rotation therapy. The two procedures will be considered separately.

Application to Eccentrically Situated Tumor: Consider irradiation of a 4-cm. spherical mass in a 12-cm. neck, as illustrated in Figure 6B. Two 45° wedge-filtered beams are to be employed as shown. All points in the plane of the section lie in the 0° isodose chart; isodose lines in this plane are readily determined from this. Points directly above or below point 0, the intersection of the beam axes, lie in the 90° isodose chart at a depth of 3 cm., and at a distance from the axes which is the distance above or below the plane of the paper. Thus, a point 2 cm. from this plane receives 46 r from each beam, per 100 r in air, or a total of 92 r. Doses for other points in planes outside the plane of the paper can be found with the contour projector. Consider points in a plane 2 cm. above or below the paper, such that *P* and *R* are their projections in the plane. For *P*, the contribution from Beam II is found from the 90° isodose chart; it is 36. To find the contribution from Beam I, after the dose finder is properly set up, the plane of the Lucite plate must be rotated 45°. The reading in the 60°

plane is 50, and in the 30° plane 60, giving an average of 65. Hence, the total dose at this point is 101 r for 100 r in air to each port. Similarly, the dose at R is found to be 90 r per 100 r to each field in air. Determination of dose at a few selected points gives a good idea of the homogeneity of irradiation throughout the mass.

Application to Horizontal Rotation Therapy: Use of the wedge filter in horizontal rotation therapy has been discussed in detail by Green, Jennings, and Bush (2), and by Quimby, Castro, and Soifer (3). In the latter paper, detailed procedures for dosage calculation are given. Use of the contour projector greatly simplifies the process, eliminating practically all of the mathematical steps. The general set-up is indicated in Figure 8A. The wax cone is used as bolus to fill in the air space; the wedge filter, oriented as shown, equalizes the dose distribution from top to bottom of the continuously irradiated region.

As the body turns about the axis AA, any point in it will describe a circle about this axis, in a plane parallel to the skin (perpendicular to the paper). Points on the axis AA always lie in the 0° isodose chart as indicated, and doses can be read directly. All other points move out of this plane as the body turns. They may remain constantly in the beam of radiation, or they may rotate out of it. The circular path of any point is indicated in Figure 8B; it has been divided into twelve segments of 15° each. The center of the first segment is marked 0°, the center of the second 15°, and so on.

The wedge field isodose chart is set up on the plate of the dose finder, tilted at the correct angle of entry into the body. The diagram bearing the circular path of a point is placed on the base, so that the center of the circle is below the intersection of the beam axis and the vertical axis of rotation. If this point of intersection is placed at the height of the pointer's tip, doses can be found for all points traveling in circles in the plane, through the center of intersection and parallel to the skin.

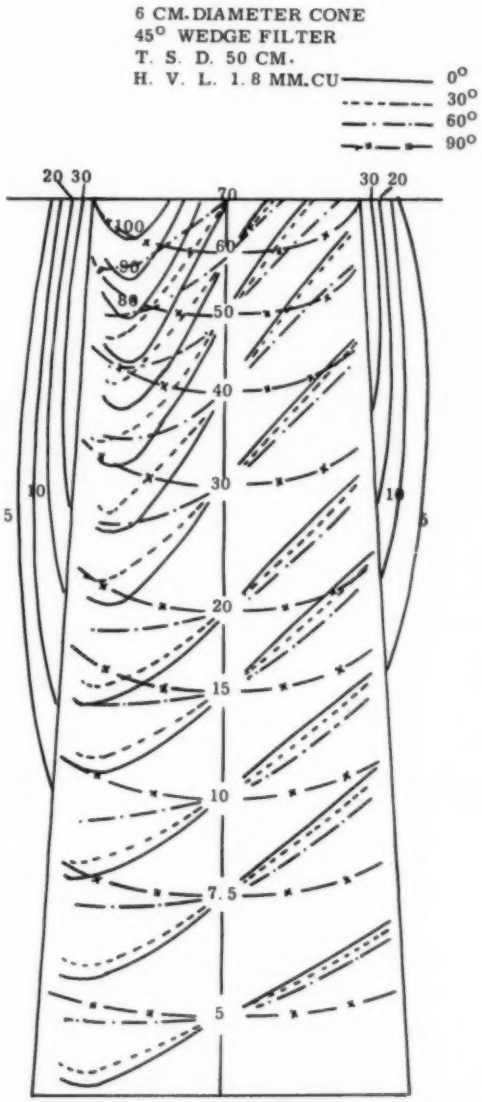

Fig. 7. Isodose charts in four planes, for 45° wedge filter. Cone 6 cm. diameter; h.v.l. 1.8 mm. Cu; F.S.D. 50 cm.

By moving the Lucite plate up or down, as indicated, doses for points moving in other planes can be determined.

The procedure is simple and direct. The line indicating 0°, the center of the first segment, is set parallel to the beam axis. The pointer is set over each segment center in turn, and the partial dose at each, per 100 r in air, is determined. The

angle of rotation of the Lucite plate, as read on the protractor, indicates which isodose chart is to be used, or between which two interpolation is to be made. It must be noted that 0° indicates the Lucite plate perpendicular (not parallel) to the base of the instrument, since this is the

these doses, previously published (3), it was necessary to pay attention to that half of the isodose chart which was to be read at any time, depending upon when the point crossed the axis of rotation. The dose finder automatically provides that the reading be made in the correct part of the

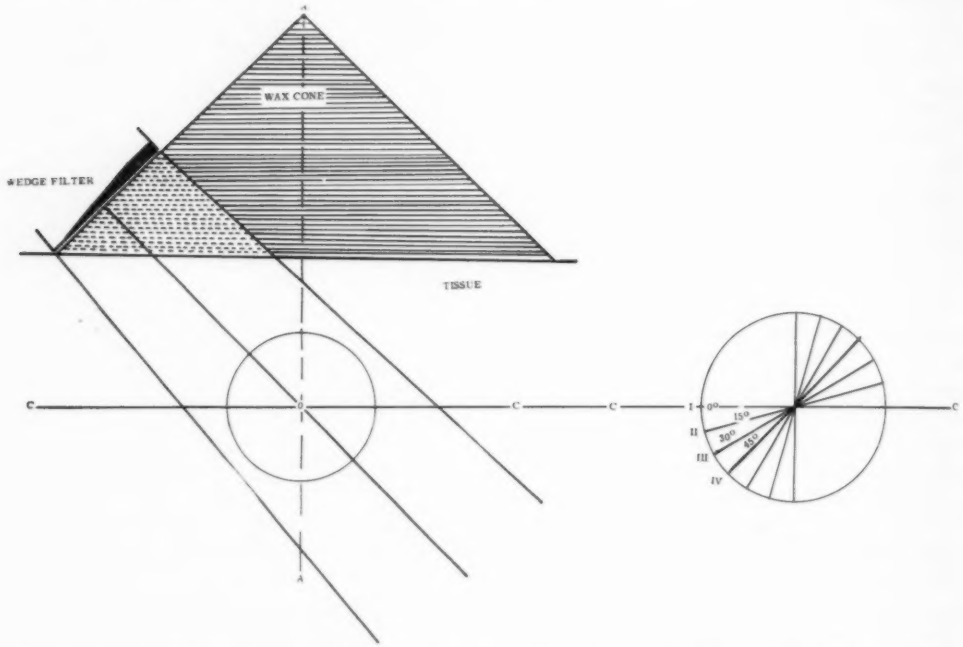

Fig. 8. Diagrams for horizontal rotation therapy. A. Section through axis of rotation and axis of beam. B. Section perpendicular to A, showing circular path of a point during rotation.

position in which the wedge exerts its greatest effect. The readings for the 0° and 180° segments will be taken directly from 0° isodose chart; all others will have to be determined from the protractor. Since the path is symmetrical, it is sufficient to determine only the values from 0° to 180°. The average dose rate is obtained by adding partial values I and XIII, for the 0° and 180° positions, twice the partials from II and XII inclusive, and dividing the sum by 24. For every 100 r in air at the position of the center of the field, without the wedge filter, the dose at the point in question is given by this average.

In the mathematical determination of chart, if the orientation of the beam is correctly visualized. Obviously, if no wedge filter is employed, the same procedure is applicable to the single isodose chart of the regular circular beam.

For points in the beam during only part of a revolution, as on the skin, the pointer will indicate the segment at which the point travels outside the beam. Beyond this, readings will be zero. It may be desirable in such a case to divide the part of the path which lies in the beam into 10° or even 5° segments, so that the rapid changes at the edge of the beam will be better accounted for. Thus, if a point travels in the beam from 330° to 30°, and outside it the rest of the time, 5° segments

from 0° to 35° or 40° should be employed. The average dose rate for such a point is 60/360 times the average rate in the irradiated sector, since during the other 300/360 of the path, no radiation is received. Isodose charts used for these calculations should carry values for the scattered radiation outside the geometrical beam. Otherwise, readings for points not continually in the beam will be too low.

In the paper by Quimby, Castro, and Soifer, mentioned above, data were presented for comparison of doses in horizontal rotation therapy as calculated by approximate and rigorous formulae and as measured in a rotating phantom. Doses for many of the same points have been obtained by means of the contour projector. In all instances, for points in the beam during the entire rotation the doses determined with the contour projector agreed, within 5 per cent, with the measured values; the same agreement was, in general, obtained with doses which were mathematically determined. For points in the beam only part of the time, contour projector and calculated values both are low. This is probably because the point is considered to receive no radiation during the entire part of the rotation after it has passed the 5 per cent contour. Actually there is an appreciable scatter contribution outside this, for which some method of correction might be established. However, since these points receive considerably less than those in the beam at all times, this may not be important. The time required for determining doses in this way is about one-tenth the time required for their careful calculation by published formulae.

DISCUSSION AND SUMMARY

The Mayneord contour projector is applicable to several types of dose finding in addition to those described in Mayneord's original paper. Manipulations are simple; written explanations are wordy, but a few minutes practice is sufficient to clarify the procedures.

The instrument was designed for use with circular beams and may be employed directly to determine doses at any point within the tissue, for any combination of circular fields. Adjustment is automatically made for different directions and angles of entry into the body. Only a single isodose chart is needed for each beam.

As originally designed, the contour projector is not applicable to rectangular fields. This is probably one reason why it has not been widely adopted in the United States, where such fields are frequently employed. A simple modification serves to extend its use to these cases; however, three isodose charts are required: one in the long axis of the field, one in the short, and one in the diagonal. These should all be plotted on the same sheet; their midline values will coincide, but the diameters and edge effects will differ. A protractor is placed on the axis of the rotating Lucite plate which carries the combination isodose chart. Determination of the angle through which the plane is rotated to make contact with the marker of the point under study indicates which isodose is applicable, or whether interpolation is to be made between two. Combinations of rectangular fields are studied almost as easily as combinations of circular ones.

A similar procedure is followed when wedge filters are employed. Four isodose charts are usually constructed for planes crossing the wedge at different angles. The angle of rotation of the plate again indicates which chart is applicable to the point in question.

The procedure is readily extended to dose determination in horizontal rotation therapy, where a point in travel during rotation assumes a series of positions within the beam. It makes no difference whether or not a wedge filter is used to improve beam homogeneity.

As the instrument becomes a familiar tool, other uses will doubtless suggest themselves.

APPENDIX

Use of the Contour Projector with Circular Beams: As outlined at the beginning of this paper, the dose

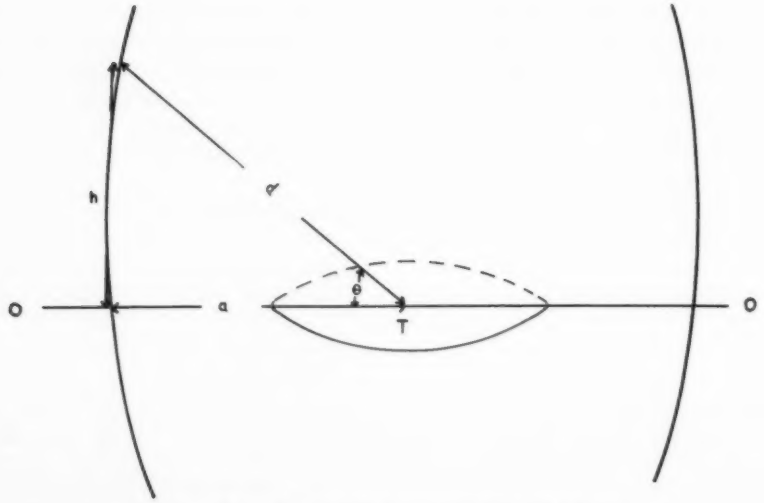

Fig. 9. Diagram illustrating geometry for angled beam.

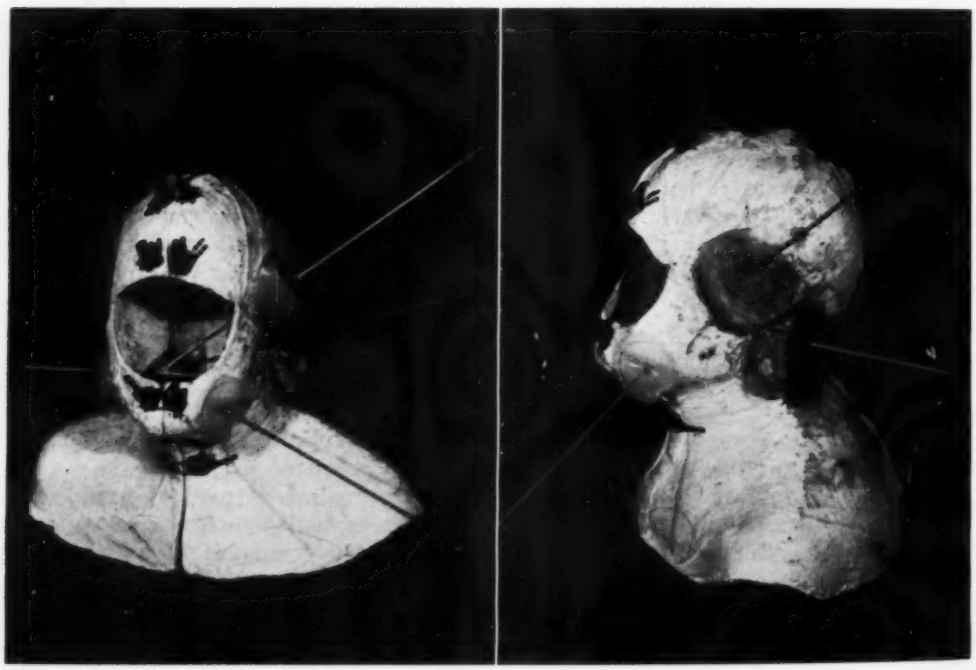

Fig. 10. Photographs of head cast for positioning patient in four-field set-up.

can be found for any point not in the axial plane of a circular beam. The isodose chart is attached to the Lucite plate; the tip of the pointer represents the designated point; the plate is rotated until contact is made between the chart and the point, and the dose is read directly. By taking a number of readings for various positions of the tripod, with the pointer tip positioned at a fixed height, values can be obtained for drawing a new isodose chart for a plane parallel to the axial plane of the beam, and at any desired distance from it.

The plane for study need not be parallel to the

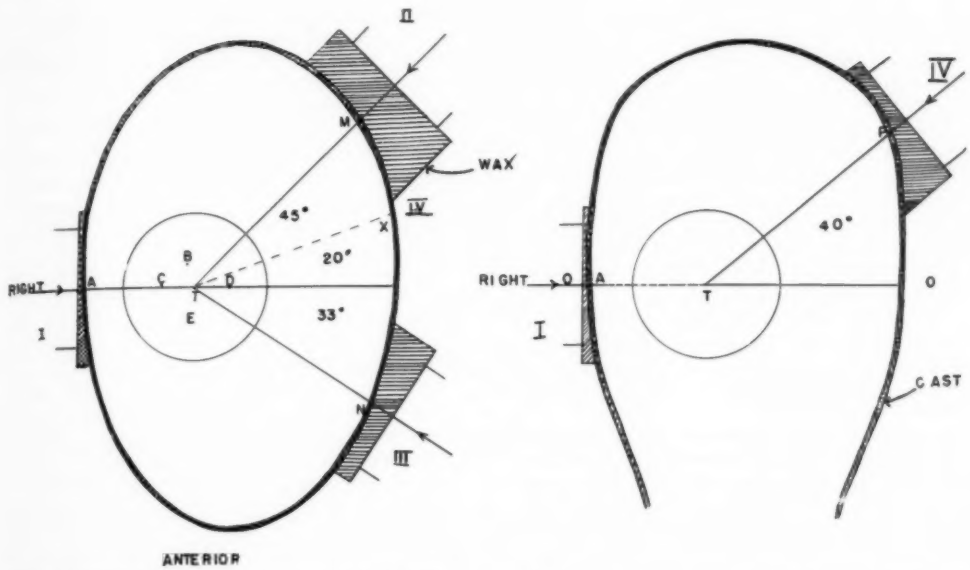

Fig. 11. Diagrams for case treated with head cast shown in Fig. 10. A. Transverse section through center of tumor, in plane of axes of three beams. B. Vertical section through center of tumor and axis of fourth beam.

TABLE I: DOSAGE DETERMINATION FOR POINTS ON FIGURE 11
(h.v.l. = 1.5 mm. Cu. F.S.D. = 50 cm. Point T, center of tumor; C, on axis, 2 cm. closer to single Port I; D, on axis, 2 cm. farther from single Port I; B, same depth as T, 1.5 cm. posterior and 1.5 cm. toward vertex; E, same depth as T, 1.5 cm. anterior and 1.5 cm. toward feet)

Field	Diameter (cm.)	Angle in Degrees		Distance Port of Entry to Center (cm.)	Dose in Roentgens at Point per 100 Roentgens in Air at Portal of Entry				
		Horizontal	Vertical		*T*	*C*	*D*	*B*	*E*
I	5	180	0	5	61	83	46	56	56
II	5	−45	0	13.0	18	15	26	22	13
III	5	33	0	8.5	38	28	48	30	41
IV	5	−20	40	14	16	12	18	18	12
Total at point per 100 r in air at each portal of entry*					133	138	138	126	122

Note: Values for *T*, at center of tumor, are read directly from isodose chart. Values for *C*, *D*, *B*, and *E* are obtained with the contour projector.

* Isodose chart constructed to give doses related to air dose rather than related to surface dose.

axis of the beam. It frequently happens that a beam enters the body at an angle from the horizontal, and that dose distribution is desired in a horizontal body section. The procedure in such a case is best described by means of a specific example: In Figure 9, let the line 00 be in a horizontal plane through the center of the tumor, *T*. The beam enters the body at a distance *h* above this plane, slanted at an angle θ so that its axis passes through *T*. The center of the tumor, *T*, is at a depth *a* below the skin. The depth of the tumor in the actual beam, *d*, can be measured from an accurately constructed diagram, or calculated ($d = a/\cos\theta$).

The depth *d* is marked on the isodose chart, which is then mounted on the plate. This is inclined from the horizontal by the angle θ, indicated on the circular scale on the support of the plate (Fig. 1A). A cross section of the patient in the horizontal plane 00 is prepared, with *T* correctly located. This is fastened to the drawing board base of the instrument in such a way that *T* on the section is directly under the position of depth *d* on the isodose chart (this can be established by use of the vertical pointer). The section is correctly oriented so that the projection of the point of entry of the beam is directly under the center of the skin field on the isodose chart (Fig. 1B).

In order to find doses in the horizontal plane through the center of the tumor, the tip of the pointer should be at the level of the depth *d* on the isodose chart. It will be in actual contact with the chart as set only as it is moved across the field on a line perpendicular to 00. For positions closer to the entrance field, the tip is below the isodose chart, and

this will have to be rotated until contact is made as described above; then the reading at the tip is the value for that point in the plane. For points farther from the entrance field, the tip would be above the Lucite plate; it is evident that this must be rotated out of the way until the position of the marker is set, and then rotated back for contact.

In plotting an isodose chart in plane 00, a considerable number of readings must be taken. More often, values at a few selected points are desired. If these points are indicated on the cross section, the marker can be set over each one in turn, and the doses determined directly.

To obtain dose distribution in another plane parallel to the first, for the same oblique beam, it is necessary only to move the yoke (carrying the Lucite plate) up or down the required number of centimeters and repeat the process outlined above. A scale on the plate support facilitates correct positioning. For a plane 2 cm. *above* the first, the yoke must be moved 2 cm. *down*, since the tip of the marker remains fixed.

Doses from several oblique fields may be summed at points, by making successive settings for the different angles and distances.

This procedure is particularly useful in cases where a plaster cast has been constructed to provide accurate beam direction, as in Figure 10. The position of the center of each entrance port is marked, and the angle of the beam axis indicated by a wire pin or knitting needle. The central ray of one field may be taken as the axis of reference, all angles are measured from it, and all distances above or below it.

As an example, consider the tumor in the head, for which the cast of Figure 10 was prepared. It is to be treated through a single port on the right side and three ports on the left. Their orientations are shown in Figure 11. On the left (Fig. 11A) is a horizontal section through the center of the lesion, indicating the position of the axis of the single beam on the right, and of two of those on the left, which lie in this plane. Figure 11B is a vertical section, also through the center of the lesion, showing the fourth port above the level of the horizontal section. The axis of the right-hand beam, AT, does not lie in this plane, but its projection is shown as a dotted line. The axis of the single beam, AT, will be taken as the line of reference; the center T as the center for angular measurements. For use with the contour projector, a single cross-section chart, in the horizontal plane, will serve, provided the angles of tilt of beams not lying in this plane are recorded. On this (life-size) section are indicated the cross section of the tumor, the axes and angles of the beams lying in the plane, AT, MT, and NT, and the projection of the beam at an angle to it, XT.

Since point T lies on the axis of each beam, when its depth in each has been established the dosage contribution at that point is read directly from the chart; the dose finder contour projector is not necessary. For all other points the cross-section diagram is set on the base of the dose finder. Each beam in turn is correctly oriented, and readings are made for all points of interest. If the axis of one of the beams does not pass through point T, but at a known distance in front of or behind it, this must be taken into consideration in setting up for that beam.

The above procedures are facilitated by placing over the diagram on the base of the apparatus a transparent polar co-ordinate scale, mounted on a second transparent sheet carrying concentric circles 1 cm. apart centered at the center of the circular scale. (These may be combined in a single sheet marked radially and circularly.) The center point of this is fixed above the position of the center of the tumor; the diagram is then readily rotated as desired, through the correct angle, and the position of the base of the marker set each time on the indicated points.

Data should be tabulated in a simple form. For the four fields in the case under discussion, something like Table I is useful.

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SUMARIO

Aplicaciones del Proyector de Contorno Mayneord a Varios Problemas Posológicos en Radioterapia

Descríbense aquí nuevas aplicaciones del proyector de contorno Mayneord a problemas de dosificación. El instrumento fué diseñado primitivamente para empleo con haces circulares, y en esos casos cabe emplearlo directamente para determinar las dosis en cualquier punto dentro de los tejidos con cualquiera combinación de campos circulares.

Una sencilla modificación sirve para extender el uso del proyector a campos rectangulares. Esto comprende la adición de un transportador circular al diseño primitivo de Mayneord y el empleo de tres gráficas de isodosis (en vez de la única gráfica usada ordinariamente), una en el eje largo del campo, la segunda en el eje corto y la tercera en el diagonal. Todas éstas se trazan en la misma hoja; sus valores en la línea media coinciden, pero los diámetros y los efectos marginales discrepan.

Con la técnica descrita, cabe estudiar combinaciones de campos rectangulares casi tan fácilmente como las combinaciones de campos circulares. El procedimiento es también aplicable cuando se emplean filtros cuneiformes y se extiende fácilmente a la determinación de la dosis en la rototerapia horizontal.

Time-Dose Studies in Irradiation of Mycosis Fungoides

Iso-Effect Curve and Tumor Lethal Dose[1]

MILTON FRIEDMAN, M.D., and ALEXANDER W. PEARLMAN, M.D

CONSTRUCTION of iso-effect recovery curves for each type of tumor is a necessary step toward improving knowledge of irradiation dosage. It is suspected, though not demonstrated, that different types of tissue have specific recovery rates. The recovery rate is also influenced by the size of the daily fraction (1). The difficulty in constructing iso-effect curves was considered in a previous paper based on the treatment of multiple chest wall nodules of recurrent breast cancer (2). The same paper discussed Strandqvist's iso-effect curve for skin cancer and indicated potential errors when data are based on patients with a single lesion.

Mycosis fungoides is a useful test object for study of the recovery rate because the multiplicity of lesions permits confirmation of each given dose by means of the *corroborated dose technic* (2) described below. Two cases, each with a large number of lesions (28 and 35, respectively), are reported below. This permitted the construction of a useful iso-effect curve for each patient. Furthermore, it became possible to compare the iso-effect curve of a markedly radiosensitive tumor with that of one which was only moderately radiosensitive.

CASE REPORTS

CASE I: E. K., a white male aged 50 years, exhibited the first lesions of mycosis fungoides in 1945 at the age of forty-two. Severe generalized pruritus was present for a period of one and one-half years, at the end of which time numerous cutaneous lesions became apparent. Repeated biopsies of skin nodules led to a diagnosis of mycosis fungoides. Between the onset of disease and the first admission to the Radiation Therapy Department of University Hospital in August 1952, the patient had been treated with Fouadin, nitrogen mustard, ACTH, roentgen irradiation, and thorium-X. These agents had produced temporary remissions. Hospitalization became necessary because of anemia, loss of weight, and severe exacerbation of the cutaneous lesions.

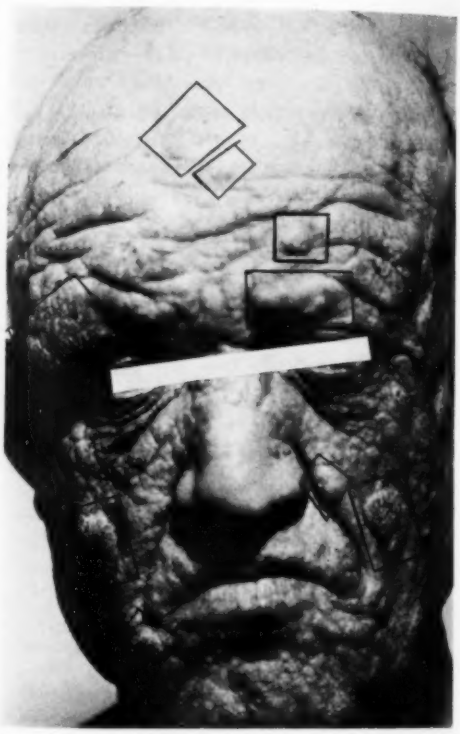

Fig. 1. Case I. Typical nodular lesions of mycosis fungoides. The treatment portals are outlined.

The patient was thin, undernourished, and showed signs of pruritus. The mycosis fungoides lesions were generalized and of three types: crusted papules, scaly plaques, and nodular tumors (Fig. 1).

Twenty-eight cutaneous and subcutaneous nodular tumors were individually irradiated. The nodules ranged in diameter from 1 to 8 cm., most of the irradiated nodules being from 2 to 4 cm. in diameter. The factors were 200 kv; 0.75 mm. Cu and 1 mm. Al filter; h.v.l. 1.0 mm. Cu; 25 cm. target-skin distance. The portal size ranged from 9 to 50 sq. cm. All doses are expressed as tumor doses measured with back-scatter.

The *corroborated dose technic*, previously

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employed by the authors in the study of recurrent skin nodules of breast cancer, was used in this case to obtain iso-effect curves based on the "minimum tumor-lethal dose." One nodule was arbitrarily given a tumor dose of 900 r in a single exposure, which was recorded as 0.35 days, as suggested by

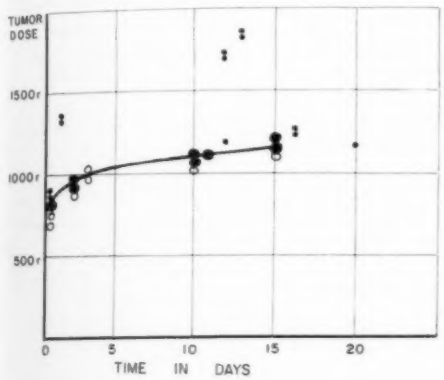

Fig. 2. Case I. Iso-effect curve based on corroborated minimum tumor-lethal doses. Circles represent failures. Small dots represent all successful doses. Large dots represent the minimum successful tumor-lethal doses for a given overall time period.

Strandqvist (2); the lesion shrank rapidly and completely. Four other nodules were given progressively smaller doses (830 r, 800 r, 750 r, and 675 r), each in a single exposure. The smallest successful dose (800 r) was designated the *corroborated minimum tumor lethal dose*, because the next smaller dose proved inadequate and the next larger dose excessive. This procedure was repeated for different overall time periods, *i.e.*, three, ten, and fifteen days (Fig. 2).

Following irradiation, the lesions were observed for a period of four to six months. For the purpose of this study, treatment was considered successful if there were no recurrences during this period.

The tumor doses are tabulated in Table I, and plotted as a scatter diagram in Figure 2. The circles represent doses which produced incomplete regression or which failed to prevent subsequent recurrence. The small dots represent successful doses. The large dots are the corroborated minimum tumor-lethal doses.

TABLE I: CASE I

Lesion	Diameter of Tumor (cm.)	Portal Area (cm.²)	Tumor Dose (r)	Overall Time*	Result†
1	1.5	10	900	0.35	S
2	2 × 3	10	830	0.35	S
3	4 × 4	20	800	0.35	S‡
4	0.75	16	750	0.35	F
5	2 × 3.5	16	675	0.35	F
6	1.5	12	1,350	1	S
7	3	12	1,350	1	S
8	1(4)	36	950	2	S‡
9	5	36	950	2	S‡
10	2	25	920	2	F
11	1.5	10	1,045	3	F
12	2.5	12	990	3	F
13	2	9	890	10	F
14	2	20	1,100	10	S‡
15	2 × 2.5	25	1,100	10	S‡
16	3(2)	36	1,080	10	F
17	3	16	1,100	11	S
18	6	16	1,700	12	S
19	7	36	1,700	12	S
20	3.5	16	1,180	12	S
21	6	50	1,850	13	S
22	6	50	1,850	13	S
23	2.5	9	1,170	15	S‡
24	3	20	1,196	15	S‡
25	2.5	9	1,170	15	F
26	2	10	1,260	16	S
27	3	12	1,260	16	S
28	3	12	1,170	20	S

* The overall time is recorded in terms of "days following the first exposure." As suggested by Strandqvist, a single exposure is recorded as 0.35 days.
† S, successful. F, failure.
‡ Corroborated minimum tumor-lethal dose.

Six corroborated dose points were plotted in the scatter diagram as large dots, and a regression curve was mathematically fitted to these minimal effective lethal dose points. The formula for this curve is

$$r = 700 + 450\ (1 - e^{0.5t})$$

where

r = minimum tumor lethal dose, in t days
t = time (in days)
e = natural base of logarithms

Because of the paucity of points, several curves of different shapes could be fitted. Hence the above curve is not too significant statistically. A freehand curve would have equal value. The formula has been offered for descriptive purposes and for comparison with other published data.

CASE II: V. R., a white male aged 53 years, was first seen in November 1950. For the previous fifteen years he had received various treatments for

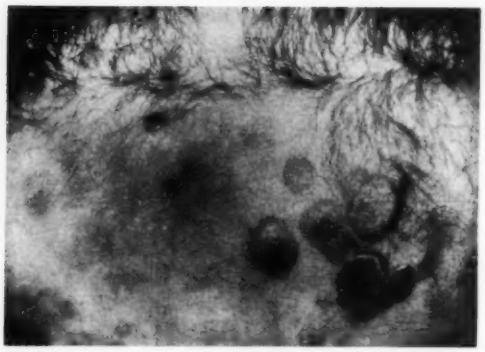

Fig. 3. Case II. Superficial plaque-like lesions of mycosis fungoides of the upper anterior abdominal wall. On the right side is the residual pigmentation following successful irradiation of several lesions.

mycosis fungoides. Numerous flat, elevated, indurated round plaques, ranging from 1 to 2 cm. in diameter and 3 to 4 mm. thick, were present in the chest and abdomen (Fig. 3). The axillary and inguinal nodes were enlarged.

Thirty-five skin nodules were individually irradiated. The irradiation factors were the same as in Case I. Two constant portal sizes were used, 4 × 4 and 4 × 5 cm. The tumor doses are tabulated in Table II and plotted as a scatter diagram in Figure 4. As in Figure 2, small dots indicate all successful tumor doses, circles indicate failures, and large dots indicate corroborated successful minimum tumor-lethal doses. A regression curve was mathematically fitted to these minimal effective dose points. The formula for this curve is

$$r = 100 + 400\,(1 - e^{-t})$$

TABLE II: CASE II

Lesion	Tumor Dose* (r)	Overall Time	Result†
1	250	0.35	S‡
2	335	0.35	S
3	500	0.35	S
4	625	0.35	S
5	200	0.35	S
6	500	0.35	S
7	600	0.35	S
8	250	0.35	F
9	200	0.35	F
10	150	0.35	F
11	200	3	S
12	300	3	S
13	400	3	S
14	500	3	S
15	504	4	S‡
16	504	4	S‡
17	504	4	F
18	500	5	F
19	500	5	F
20	500	5	F
21	500	6	S‡
22	750	6	S
23	1,000	6	S
24	240	6	F
25	240	6	F
26	360	6	F
27	360	6	F
28	300	6	S
29	400	6	S
30	1,800	13	S
31	1,800	13	S
32	1,000	14	S
33	1,400	15	S
34	1,200	15	S
35	750	15	S

* Portal sizes were 4 × 4 and 4 × 5 cm.
† S, successful. F, failure.
‡ Corroborated minimum tumor-lethal dose.

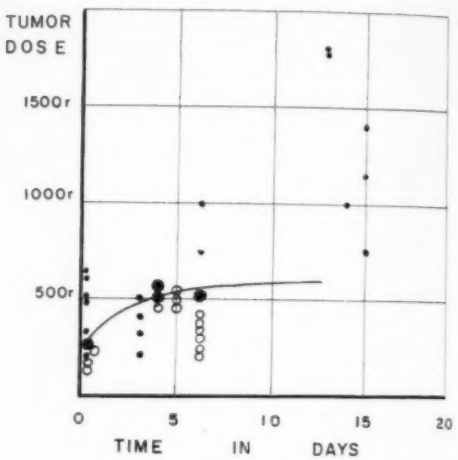

Fig. 4. Case II. Iso-effect curve similar to that shown in Figure 2. The circles represent failures. Small dots represent all successful doses. Large dots represent the minimum successful tumor-lethal doses for a given overall time period.

The comments on the formula for the curve in Case I apply equally to Case II.

DISCUSSION

Although a number of cases of mycosis fungoides were available for analysis, only 2 are reported herein because their numerous lesions permitted corroboration of the minimal tumor lethal dose for each overall time. The data yielded a statistically valid iso-effect curve for each patient.

It is useful to express the radiosensitivity of a tumor in terms of a tumor-lethal dose given in a single exposure, provided this factor is derived statistically or by some other form of corroboration (Table III).

In Case I, the minimum lethal dose was 800 r. All the other lesions fell into a similar category of moderate radiosensitivity, with slight variation dependent on the overall treatment time. In Case II, the comparable single exposure lethal dose was 250 r and all other lesions exhibited similar marked radiosensitivity.

The iso-effect curves of the 2 cases are compared in Figure 5. The difference in

TABLE III: VERIFIED TUMOR-LETHAL DOSES IN A SINGLE EXPOSURE

Lesion	Dose	Author	Method of Derivation
Mycosis fungoides: Case 1	800 r	Friedman and Pearlman	Corroborated dose
Mycosis fungoides: Case 2	250 r	Friedman and Pearlman	Corroborated dose
Skin cancer	2,200 r	Strandqvist	Statistical average
Recurrent breast cancer	2,000 r	Friedman and Pearlman	Corroborated dose

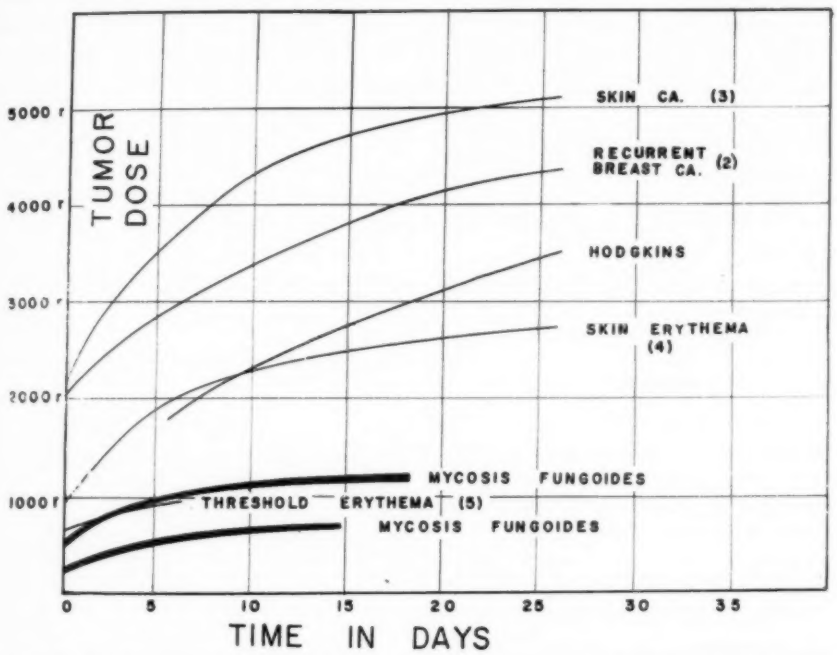

Fig. 5. The two mycosis fungoides iso-effect curves are compared with other published curves. The numbers indicate bibliographic references. The Hodgkin's disease curve is obtained from unpublished data of Milton Friedman.

radiosensitivity may be explained in part by the difference in the type of lesion. In Case I, the nodular lesions were large and infiltrating, and extended into the subcutaneous tissues. In Case II, the lesions were flat, superficial, and small. This is consistent with other malignant lymphomas, which exhibit considerable variation in radiosensitivity from patient to patient.

The slope of the two mycosis fungoides curves is similar, suggesting a similar recovery coefficient for both tumors. The flattening of the curve after the fifth day suggests that these radiosensitive lymphomas show little tendency to recover from radiation effects.

Current Inventory of Useful Iso-effect Curves: A number of iso-effect curves with different degrees of usefulness have been collected in Figure 5 for analysis and comparison. The skin erythema curves of Reisner (4) and Quimby (5) are reliable, since they are based on a test object exhibiting the least individual variability.

The Strandqvist (3) skin cancer curve, although based on a single lesion in each patient and therefore lacking in corroboration, still has some validity because of the

care in its derivation and construction. It serves further as a useful clinical guide in the treatment of skin cancer.

The recurrent breast carcinoma iso-effect curve of Friedman and Pearlman (2) should have had considerable validity as it was obtained by the corroborated dose technic. However, the marked variation in radiosensitivity in different patients with breast cancer is such that a statistically useful average iso-effect curve or fractionation factor could not be obtained. As a clinical guide, the doses indicated by the curve are lethal for 75 per cent of the lesions.

The Hodgkin's disease curve of Friedman, hitherto unpublished, is for various reasons less reliable than the above curves. It is presented here because it is useful as a clinical guide.

The mycosis fungoides curves depict the relative recovery in highly radiosensitive tumors.

SUMMARY

1. In order to establish an iso-effect recovery curve for a specific tumor or type of tumor, the *corroborated dose technic* should be employed, the curve being based on *minimum tumor lethal doses*. This technic reduces the enormous clinical errors inherent in any iso-effect curve.

2. Two patients with multiple lesions of mycosis fungoides (28 and 35 lesions, respectively) were irradiated with different doses in different overall time periods, according to the corroborated dose technic.

3. An iso-effect curve was constructed for each patient and the two curves compared with each other and with curves previously published. A mathematical recovery or fractionation factor was derived for each curve, but was not entirely valid, since the paucity of points permitted several types of curves to be fitted to each group of points. Nevertheless, the curves in the present report are more accurate than those previously published, with the exception of those for skin erythema. The curves are useful guides for clinical radiation therapy of mycosis fungoides.

4. The radiosensitivity classification of any tumor is usefully symbolized in terms of the *corroborated minimum tumor-lethal dose for a single exposure (0.35 days)*. In the 2 cases reported, this dose was 250 r and 800 r, respectively. For skin cancer it is 2,200 r, and for recurrent breast cancer it is 2,000 r (Table III). This does not imply, however, that the above lesions are treated preferably by a single dose of irradiation.

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SUMARIO

Estudios del Tiempo-Dosis en la Irradiación de la Mycosis Fungoides Curva del Iso-Efecto y Dosis Letal del Tumor

A fin de establecer una curva de recuperación del iso-efecto para un tumor o tipo de tumor especifico, considérase que debe emplearse la *técnica de la dosis corroborada*, basando la curva en *dosis letales mínimas para el tumor*. Esta técnica disminuye los enormes errores clínicos inherentes en toda curva de iso-efecto.

Preséntanse las historias clínicas de 2 enfermos que tenían lesiones múltiples de *mycosis fungoides*, irradiadas con distintas dosis en distintos períodos globales de

tiempo, conforme a la técnica de la dosis corroborada. Construyóse una curva de iso-efecto para cada enfermo, comparándose las dos curvas entre sí y con curvas publicadas anteriormente. De cada curva se derivó un factor matemático de recuperación o fraccionación, pero sin ser absolutamente válido, dado que la escasez de puntos permitía que varias formas de curvas se ajustaran a cada grupo de puntos. No obstante, las curvas ofrecidas en la comunicación actual son más exactas que las presentadas anteriormente, con excepción de las relativas al eritema cutáneo. Las curvas se consideran como guías útiles para la radioterapia clínica de la micosis fungoidea.

Simbolízase útilmente la clasificación de la radiosensibilidad de cualquier tumor en términos de *dosis letal mínima corroborada para el tumor con una sola exposición* (*0.35 días*). En los 2 casos presentados, esta dosis fué de 250 r y 800 r, respectivamente. Para el cáncer cutáneo, es de 2,200 r y para el cáncer mamario recurrente, de 2,000 r. Esto no denota que se traten preferiblemente las lesiones mencionadas con una sola dosis de irradiación.

Gout as a Cause of Isolated Circumscribed Cyst of the Patella

Report of a Case[1]

JOHN LYFORD, III, M.D.,[2] and DAVID SHAPIRO, M.D.[3]

ISOLATED, circumscribed cysts of the patellae are of great interest to the radiologist and orthopedic surgeon because of their differential diagnostic and therapeutic significance. A cystic lesion in the patella may indicate such generalized or systemic conditions as leukemia, multiple myeloma, fibrous dysplasia, cystic tuberculosis of bone, reticulosis, metastases, or metabolic disorders. Such a lesion may, on the other hand, be primary in the patella, as a solitary "benign" cyst or hemangioma or tumor of bone.

A search of the literature revealed no record of a solitary cyst-like area in the patella related to gout. The present case is reported, therefore, as an example of a solitary patellar lesion indicating a major systemic condition, *i.e.*, a metabolic disease. It serves to re-emphasize the fact that in such instances final therapy can be instituted only after a diagnosis has been established and that the determination of the nature of cystic lesions of bone must be made by biopsy.

CASE REPORT

W. E. M., a 34-year-old white male, was seen in the Veterans Administration Hospital, Louisville, Ky., on Feb. 26, 1954, complaining of pain in the right knee. While in the Armed Forces in 1943, the patient had experienced pain and swelling of this knee, which, however, had cleared up spontaneously. During the subsequent five years he had felt only occasional soreness in the right knee. In 1953, the right ankle became swollen and painful, but these symptoms subsided in about one week. Following this, the patient experienced periodic pain in both knees, with no associated swelling or redness until one month prior to admission to the hospital, when pain, swelling, and stiffness developed in the right knee. About five days later the left great toe and left foot became painful and swollen; six days prior to admission to the hospital the right knee again became quite swollen, hot, and red.

Findings on *physical examination* were: weight 182 lb., temperature 98.6°, pulse 132, blood pressure 138/105. The right knee showed local heat, redness, swelling, and increased free fluid in the joint. Only slight swelling of the left knee was noted, with no redness or heat. There was tenderness of the left first metatarsophalangeal joint but no swelling or redness of the left foot or great toe. Other physical findings were not unusual.

Laboratory studies were as follows:

Urine: sugar, none; albumin, none; sp. gr., 1.013; occasional urates.

Red blood count, 4,750,000.

Hemoglobin, 13.7 grams.

White blood count, 12,700: segmented neutrophils, 37 per cent; "stab" forms, 32 per cent; lymphocytes, 18 per cent; monocytes, 8 per cent; eosinophils, 4 per cent; basophils, 1 per cent.

Sedimentation rate, 45 mm./hour.

Serologic test for syphilis, negative.

Blood uric acid, 9.1 mg. per cent.

Blood non-protein nitrogen, 32.3 mg. per cent.

Fasting blood sugar, 127 mg. per cent.

Roentgenographic studies of the right knee joint (Fig. 1) showed a cyst-like lesion occupying the upper two-thirds of the patella. On the tangential view an irregular mass just lateral to the patella was visualized. No other bone or joint structures of the right knee were involved. In the area of the left knee joint a bipartite patella was found but no other definite abnormalities were noted. The left foot showed no osseous nor articular abnormalities.

Chest roentgenograms were normal.

The *clinical course* was characterized by marked improvement, with relief of pain and swelling of the involved joints, under colchicine therapy. Because of the persistence of the cystic lesion, however, and the need for a definitive diagnosis, a biopsy of the

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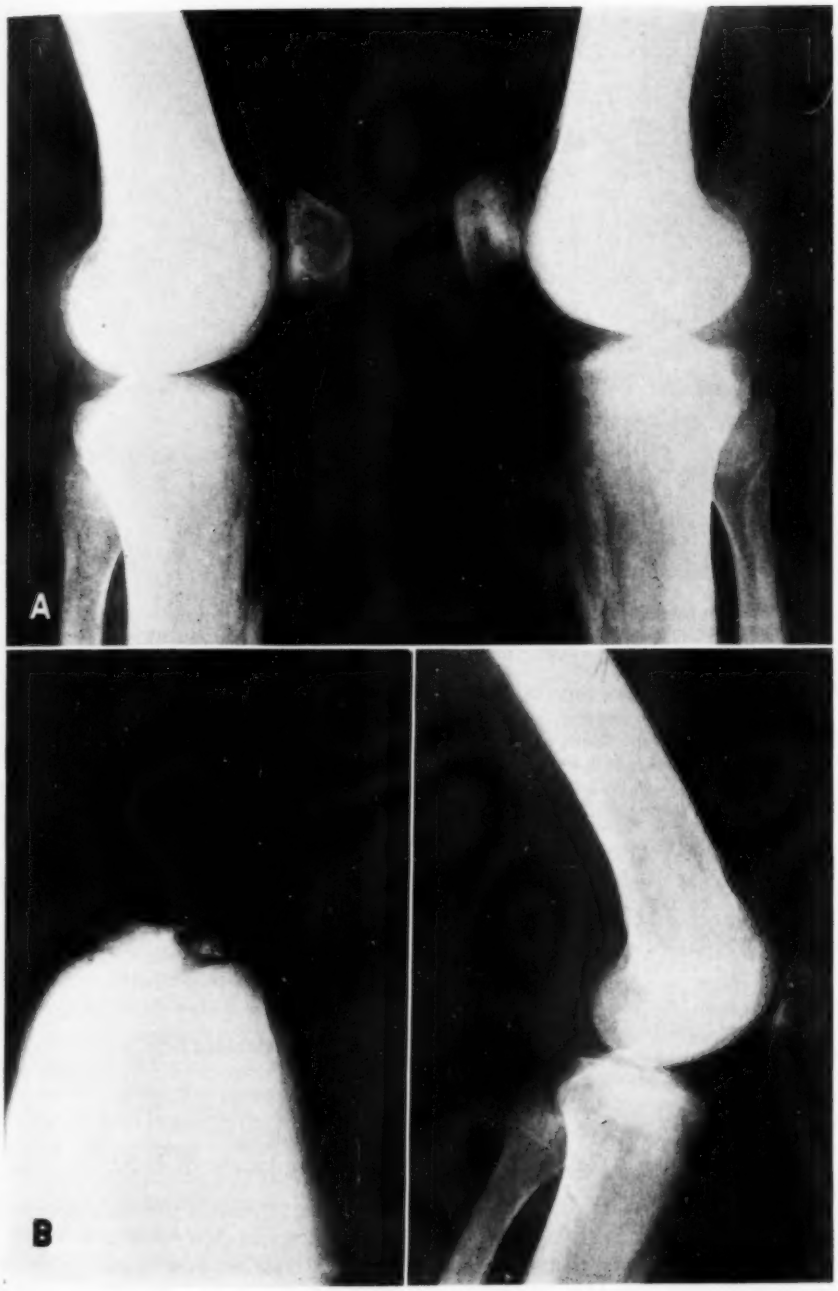

Fig. 1. A. Lateral view (preoperative) of both knees, showing cyst-like lesion in the right patella. Note absence of lesions in other bones adjacent to the involved joint.

B. Tangential and lateral views (preoperative) of the right knee showing cyst-like lesion in the patella. Note irregular mass just lateral to the patella in the tangential view, and absence of lesions in other bones about the involved joint.

Fig. 2. Roentgenograms of right knee five months after operation and anti-gout therapy had rendered the patient asymptomatic. The cyst-like lesion in the patella, however, persists.

right patella was performed two months after admission to the hospital. At operation, a cystic mass was found, occupying the upper third of the patella in its superior-lateral aspect. It contained a thick, white, paste-like material. Pathologic and chemical studies of the material were positive for uric acid crystals and for uric acid.

Treatment with colchicine and diet was continued. The patient was still asymptomatic when last seen, five months after surgery. However, roentgenograms of the right patella at this time showed the cyst-like lesion still present (Fig. 2).

SUMMARY

A solitary cyst-like lesion of the patella, proved by biopsy and laboratory studies to be caused by gout, has been described. No other report of such a lesion in the patella related to gout has been found in the literature. The case is considered of interest, also, because of the significance to radiologists and orthopedic surgeons of cyst-like lesions in the patella as an indication of possible systemic disease.

ADDENDUM: Ten months subsequent to the acceptance of the present paper for publication, there appeared a similar report by Peloquin and Graham (New England J. Med. **253**: 979, Dec. 1, 1955).

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SUMARIO

La Gota como Causa de Quiste Circunscrito Aislado de la Rótula

Preséntase un caso de lesión quistoidea solitaria de la rótula, en que la biopsia y estudios de laboratorio demostraron que la causa residía una afección orgánica, a saber, gota. Se describe la observación radiográfica de la lesión. Parece que el caso es interesante por no haberse descubierto ninguna descripción de lesión semejante en relación con la gota y debido a la importancia que tienen las lesiones quistoideas en la rótula como indicaciones de posible afección constitucional.

Periosteal Chondroma

A Report of Two Cases[1]

S. B. FEINBERG, M.D.,[2] and LIEUT. M. C. WILBER, MC, USN[3]

IN OCTOBER 1952 and May 1953, we had the opportunity of making a preoperative diagnosis of periosteal chondroma, an entity which was described in detail by Lichtenstein and Hall (1) in July 1952. Inasmuch as their account of 6 cases involving the hands, long bones, and feet provided the only complete clinical, radiologic, surgical, and pathologic description of the condition, it was felt that a further report might be useful.

As Lichtenstein pointed out, Mason (2) used the term periosteal chondroma in a paper on tumors of the hand in 1937. Schinz, Baensch, Friedl, and Uehlinger (3) briefly refer to "parosteal" chondromas, which may be the soft-tissue phase of the same entity or perhaps a form of extraperiosteal chondroma.

Periosteal chondromas are small, slow-growing, cartilaginous tumors developing within and beneath the periosteum as lobulated masses of hyaline cartilage. Histologically, they are more cellular than ordinary osteochondromas or enchondromas. Lichtenstein notes that the plump cartilage cell nuclei tend to indicate active growth, a finding not borne out by the clinical course. The lesion shows no predilection for either sex or any age group. A slow-growing soft-tissue mass is the usual presenting symptom. Occasionally, localized pain in the absence of a history of trauma is the primary complaint.

By definition, periosteal chondroma must arise from the periosteum and result in pressure changes in the adjacent cortex. Roentgenograms reveal a small soft-tissue mass and an associated cortical excavation with a sclerotic border. If calcium flecks are deposited in the lesion, its cartilaginous origin becomes obvious. Roentgen visualization in two planes is imperative in order to avoid false localization of the cortical defect.

Treatment consists in simple excision of the cartilage lobule and curettement of the sclerotic cortical base, or block excision of the involved area.

Osteochondroma, solitary enchondroma, and extraperiosteal chondromas are the more common conditions to be differentiated from periosteal chondroma. Neurofibroma and simple fibroma must also be considered. In the vicinity of joints, bone erosion caused by synovioma, although infrequently seen (4), must be kept in mind in differential diagnosis. Glomus tumor of the phalanges is another remote possibility.

CASE REPORTS

The following cases fulfill the criteria listed above:

CASE I: A 27-year-old white male was seen on Oct. 9, 1952, with an eight-year history of intermittent painful swelling, without heat or redness, localized at the superior margin of the left calcaneus at its posterior border. During his first illness, in 1944, he had obtained symptomatic relief by means of simple soaks and heat. Late in 1949, the swelling recurred and spread posteriorly to the Achilles tendon. This region remained firm and thickened to palpation, and in September 1952 an exacerbation occurred, characterized by severe pain on pressure and motion. Because of persistence of the pain, the patient was hospitalized and at that time came to the authors' attention.

Physical findings were limited to a localized non-discrete soft-tissue mass at the level of the insertion of the Achilles tendon on the left, extending to the bursal space superior to the tendon insertion. Results of routine blood studies, as well as blood chemistry and urinalysis, were normal.

Radiographic Examination (Figs. 1 and 2): The right ankle and foot were normal roentgenographically. On the left, a non-discrete soft-tissue shadow

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partially obliterated the bursa at the posterior superior aspect of the calcaneus. In addition, immediately anterior to the Achilles tendon was a small sclerotic concavity of the cortical margin of the calcaneus, measuring 1.5 × 0.75 × 0.5 cm. At the superior margin of the involved area was a slight irregularity of the bone projecting into the soft-tissue shadow. The findings were compatible with a diagnosis of periosteal chondroma as described by Lichtenstein.

Surgical exploration of the posterior dorsal aspect of the left os calcis on Oct. 20, 1952, revealed a large bursa and a small, white, firmly lobulated mass, which was removed. The initial histologic diagnosis was inconclusive, and the only impression was that of chronic bursitis.

After a two- to three-week period of clinical improvement, the patient's symptoms returned. On Jan. 13, 1953, he was hospitalized again, at which time the soft-tissue changes at the Achilles tendon attachment were noted in association with the operative scar. Radiographic findings were as reported above except for a slight alteration in the soft-tissue shadow. The area was re-explored on Jan. 23, and a sclerotic cortical impression devoid of the original soft-tissue mass was found. A block

Fig. 1. Case 1: Twenty-seven-year-old white male, with an eight-year history of intermittent pain, and a permanent soft-tissue mass over the posterolateral aspect of left heel. A. Normal lateral projection of right calcaneus. B. Scalloped erosion of posterior aspect of calcaneus with underlying cortical sclerosis. On the original roentgenograms a soft-tissue mass was also delineated.

Fig. 2. Case 1: Tangential views of normal right calcaneus and eroded posterior left calcaneus.

excision was done and a piece of periosteum and involved cortex, including the underlying bone to a depth of 1.5 cm., was excised.

In view of the fact that the sections from the second specimen showed areas of periosteal chondroma, the original tissue was sectioned further and the typical cartilaginous cells were found.

Fig. 3. Case II: Forty-one-year-old white female with a ten-year history of intermittent pain over the posterolateral aspect of right heel. Lateral view of the right calcaneus, showing multiple scalloping of posterior aspect of cortical margin with fine border of underlying bone sclerosis. A poorly defined soft-tissue mass is apparent on the original film.

Pathologic Report: Although the tissue was removed in fragments, microscopic examination of the lesion suggested that the tumor was composed of lobules of hyaline-type cartilage separated by varying amounts of fibrous stroma. In some areas, the cartilage cells appeared to be increased in size, with relative decrease in the ground-glass or basophilic matrix. Focal areas of calcification and hyalinization were evident in parts of the matrix, at the periphery. A fibrous connective-tissue band contiguous with portions of the matrix was suggestive of a segment of capsule-like structure. Bits of osseous tissue removed in the vicinity of the lesion showed degenerative changes as well as focal areas of calcification.

Histologically, this lesion seemed to be a benign tumor. A correlation of the gross and microscopic features, along with the clinical findings, indicated that it was a periosteal type of chondroma, arising from the vicinity of the tuberosity of the calcaneus.

Fig. 4. Case II: Tangential view of right calcaneus showing area of cortical erosion and bordering sclerosis.

CASE II: A 41-year-old white female gave a ten-year history of intermittent pain in the right heel. In 1948 she was told that her discomfort was due to a "spur." Early in the course of the disease relief was obtained by rest, but later this ceased to afford subjective improvement.

Positive findings on admission (May 1953) were limited to minimal swelling over the lateral aspect of the right calcaneus, with local tenderness over the lateral insertion of the tendon of Achilles and associated pain to palpation over the lateral tuberosity of the calcaneus.

The initial roentgenograms obtained in this department (Figs. 3 and 4) showed a scalloped erosion with a sclerotic border on the posterodorsal and lateral aspect of the right calcaneus, best seen on the tangential projection. These findings were compatible with a diagnosis of periosteal chondroma.

On June 3, 1953, a yellowish white lobulated cartilaginous mass and adjacent involved bone were removed from the posterolateral aspect of the calcaneus. The postoperative course was uneventful.

Pathologic Report: Sections showed an irregular mass of cancellous bone. At one point on the surface was a fairly broad and deep area of proliferating hyaline cartilage, well differentiated and fading into bone of normal appearance at its borders. The marrow spaces of the latter were occupied largely by reticular connective tissue and fat in which there

were scattered lymphocytes and plasma cells. The cartilage was covered peripherally by periosteum. No evidence for specific infection or malignant growth was found.

Diagnosis: Periosteal chondroma.

SUMMARY

Two cases of periosteal chondroma are presented which fulfill the criteria outlined by Lichtenstein and Hall (1). In each instance the lesion originated in the region of the calcaneus, in an adult. Development was slow, over periods of eight and ten years, respectively. Small palpable soft-tissue masses were evident in both cases. Radiographically, smooth bone erosion and cortical sclerosis with associated soft-tissue changes were demonstrable.

The masses were small, firm, and lobulated in appearance. On section, they were found to be composed of nests of hyaline cartilage cells. While these were considered somewhat atypical by some observers, no evidence of malignant growth or infection was present. Treatment in each case was conservative block excision.

ACKNOWLEDGMENT: We wish to thank Comdr. John Shaver, MC, USN, Chief of Pathology Department, U. S. Naval Hospital, Chelsea, Mass., for his aid in examination and review of the microscopic sections described in the above reports.

The views expressed above are those of the authors and do not necessarily reflect the opinion or policy of the Bureau of Medicine and Surgery of the Navy Department.

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SUMARIO

Condroma Perióstico. Presentación de Dos Casos

Los condromas periósticos son pequeños tumores cartilaginosos de desarrollo lento, que se forman dentro y debajo del periostio en forma de masas lobuladas de cartílago hialino. Histológicamente, son más celulares que los osteocondromas o encondromas ordinarios.

Por su definición, la lesión debe arrancar del periostio, produciendo así alteraciones por presión en la corteza adyacente. Las radiografías muestran una pequeña tumefacción de tejido blando que ocasiona excavación cortical de borde esclerosado. Si se depositan copillos de calcio en la lesión, la génesis cartilaginosa se vuelve manifiesta. La visualización roentgenológica en dos planos es imperativa a fin de evitar la falsa localización del defecto cortical.

Preséntanse 2 casos, que cumplen estas normas, con lesiones originadas en la región del calcáneo. El tratamiento fué la excisión conservadora en bloque.

Orbital Pneumotomography[1]

WILLIAM DUBILIER, Jr., M.D., HERBERT von GAL, M.D., ALAN FREEMOND, M.D., and JOHN A. EVANS, M.D.

EXAMINATION of the orbit by conventional radiographic technic has been useful in determining osseous abnormalities and localizing foreign bodies but is of little value in the demonstration of soft-tissue tumors in the retrobulbar space. Plain radiographs fail to give much needed information regarding the diagnosis and localization of suspected retrobulbar tumors until secondary changes in the bony orbit become evident. Sectional radiography without a contrast medium also fails to show soft-tissue tumors in the retrobulbar space, while artificially produced emphysema with routine radiographs is unsuccessful because of the superimposition of various densities of bone, air, and soft tissue. The combination of retrobulbar air with sectional radiography not only aids in demonstration of these tumors but also localizes and delineates their borders. Although this procedure has been described in the literature by de Abreu of Brazil and by some European authors, there has been no report of its successful use in this country. To this method of examination we have given the name "orbital pneumotomography."

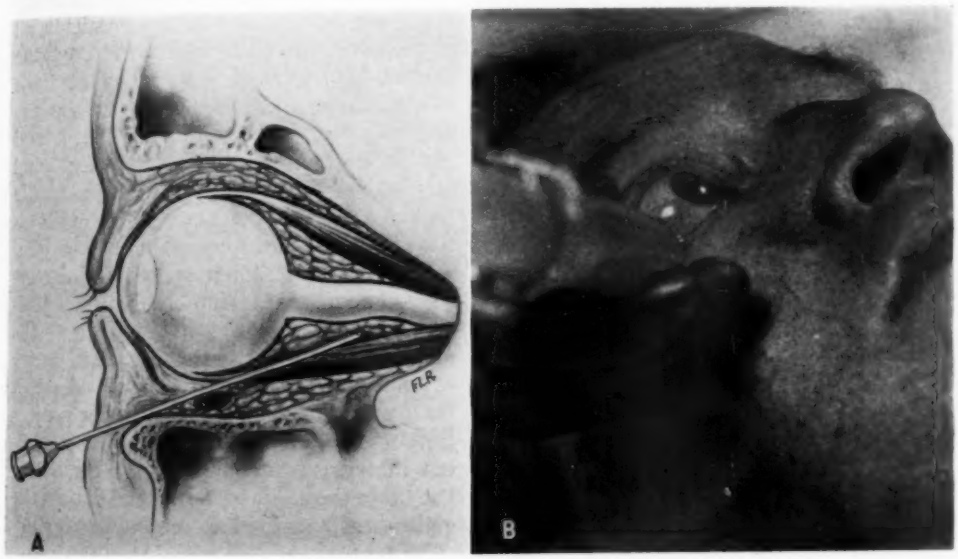

Fig. 1. A. Sagittal section of orbit and its contents, with the retrobulbar needle in place for the injection of 10 to 15 c.c. of air.
B. Photograph of patient with retrobulbar needle in place.

TECHNIC

For the performance of orbital pneumotomography a 23-gauge, 5-cm. retrobulbar needle attached to a 20-c.c. syringe is introduced through the skin of the inferior temporal angle and inserted, inferiorly to the bulb, up into the muscle cone of the retrobulbar space. The method of insertion and positioning of the needle are the same as for the induction of ophthalmoplegia in intraocular surgery (Fig. 1). Ten to 15 c.c.

[1] From the Department of Radiology and Section of Ophthalmology of the Department of Surgery, The New York Hospital-Cornell Medical Center. Accepted for publication in February 1955.

Fig. 2. Emphysema of lids and bulbar conjunctiva following the injection of 15 c.c. of air. Exaggeration of the exophthalmos is noted.

of air is then injected rapidly into the muscle cone, the globe is seen to proptose, and emphysema of the conjunctiva and lids occurs (Fig. 2). As the needle is withdrawn, approximately 2 c.c. of air is injected outside of the muscle cone. A topical conjunctival anesthetic is used to diminish discomfort resulting from inverted eyelids. No attempt is made to aspirate the air at the completion of the procedure and it is usually absorbed within twenty-four to forty-eight hours. A pressure dressing is placed over the eye at the conclusion of the examination.

Following the induction of emphysema, true lateral tomograms are obtained of the orbit from 2 to 5 cm. above the table top at 0.5 cm. intervals. In most patients, all of the orbit from the zygoma through the medial orbital wall is included at these levels. After these films are taken, the patient's head is rotated so that the lateral end of the nose, supra-orbital ridge, and maxilla are against the radiographic table (optic foramen position). The orbit is thus projected as a pyramid seen end on, with the optic foramen at its apex. Body-section roentgenograms taken in this position provide planes at right angles to the long axis of the pyramid and afford easier evaluation of the anatomy of the orbit than would a true postero-anterior projection. The tomograms are taken at 0.5-cm. intervals from 0.5 cm. to 5.5 cm. above the table top. These levels encompass the globe and retrobulbar structures, includ-

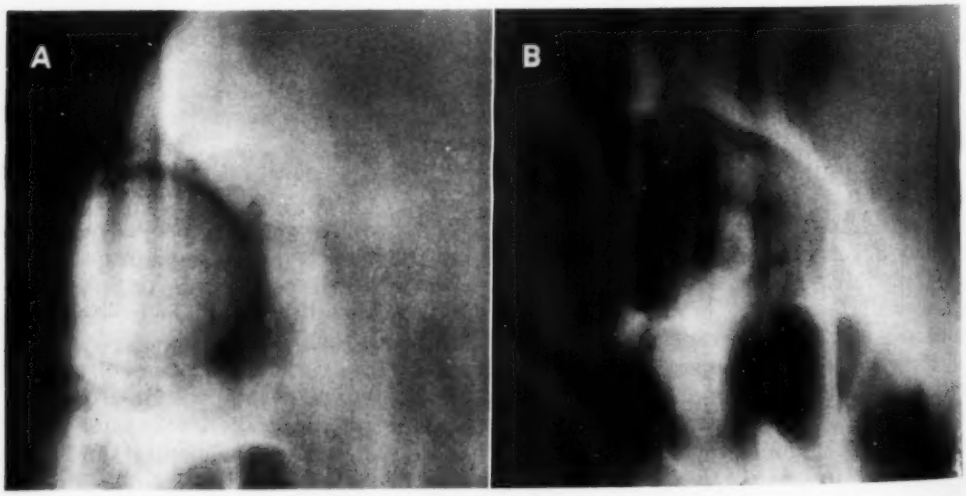

Fig. 3. A. Lateral section at 3 cm. demonstrates the globe outlined by air, with insertion of the superior rectus muscle.
B. Lateral section at 4.5 cm. shows the globe and three extra-ocular muscles.

ing the optic foramen, in almost all patients.

Technical factors have varied from relatively high kilovoltage, 100 kv in the rotated frontal position and 95 kv in the lateral position, both with 2 ma at four seconds, to what we now consider most

Fig. 4. Lateral section at 3.5 cm. showing globe with insertion of optic nerve.

satisfactory, 72 kv for the rotated frontal position and 62 kv for the lateral position, both with 30 ma at two seconds. Small variations in kilovoltage are necessary to compensate for different head densities. We take a test level in each position to insure proper radiographic technic, and then proceed with the remainder of the examination.

INTERPRETATION

In the lateral projection the globe can be seen at various tomographic levels to be encompassed by air and soft-tissue bands of the individual extra-ocular muscles (Fig. 3). Frequently, a film through the mid-plane of the orbit shows the optic nerve coming off the posterior aspect of the globe (Fig. 4). When orientation of these normal soft-tissue densities is achieved, abnormal soft-tissue tumors are more easily identified.

In the rotated frontal projection, tomo-

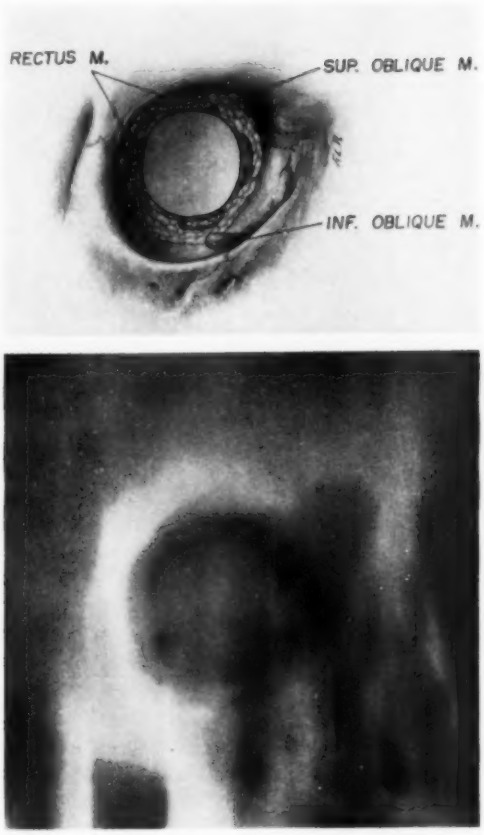

Fig. 5. An anatomic diagram of a transverse section through the orbit shows the globe surrounded by the rectus and oblique muscles. Radiographically the rotated frontal section at 1 cm. above the table top shows the globe in relation to the extra-ocular muscles.

grams through the anterior portion of the orbit demonstrate the circular globe surrounded by air. At each quadrant of the globe the extra-ocular muscles can be seen as thin strips of increased density closely related to its surface (Fig. 5). Radiographs obtained in more posterior planes reveal the optic nerve as a small density about 4 mm. in diameter, outlined by air, in the center of the muscle cone (Fig. 6). Here again, orientation of the normal soft-tissue densities will help in the differentiation of abnormal masses from normal conditions.

This procedure has been used in the New York Hospital Cornell Medical Center

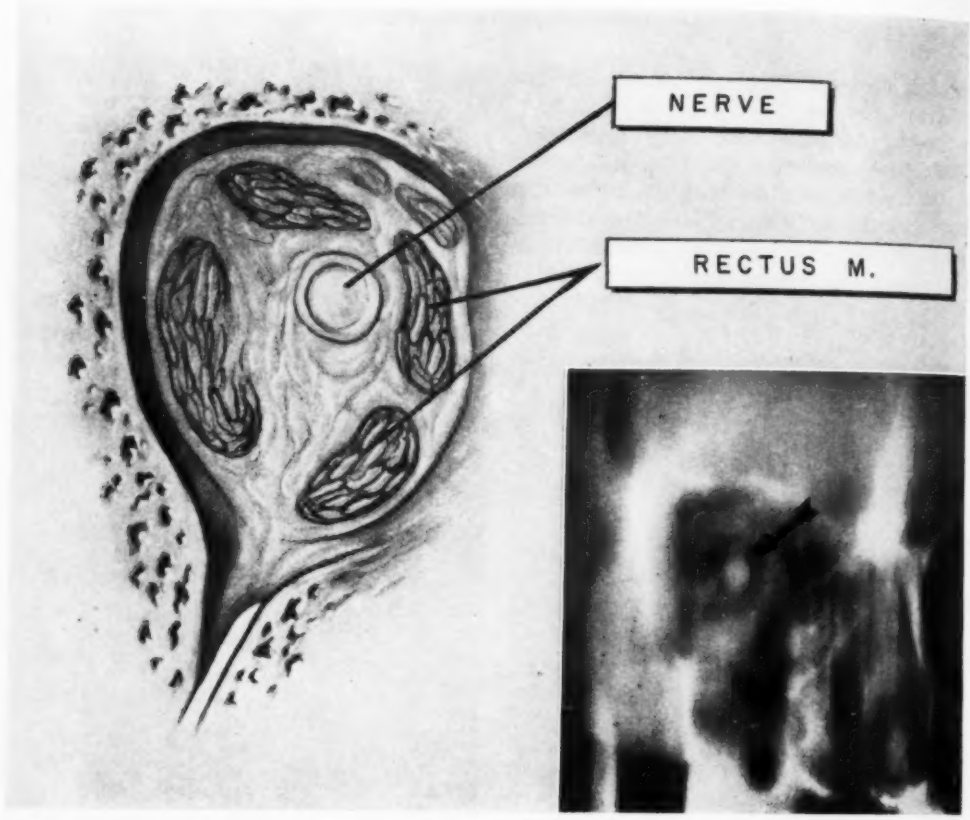

Fig. 6. An anatomic diagram of a transverse section shows the muscle cone with the optic nerve in its center posterior to the globe. In the radiographic section at 3 cm. above the table top the optic nerve is seen within the muscle cone.

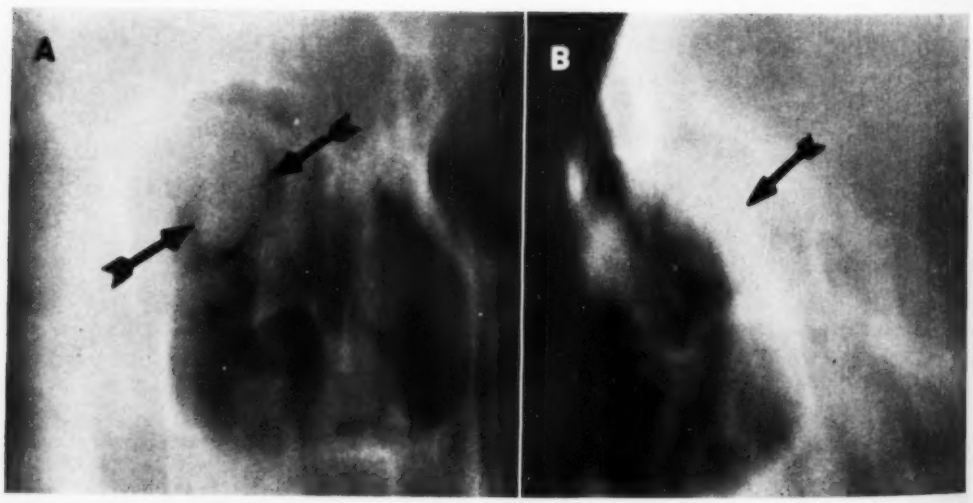

Fig. 7. A. Radiographic section in rotated frontal position at 3 cm. demonstrates a large tumor in the posterior portion of the orbit.

B. A lateral radiographic section from the same case, at 4 cm., demonstrates the large tumor circumscribed by air. See also Fig. 7C, on opposite page.

in 12 cases of unilateral exophthalmos in which either a tumor was suspected or it was necessary to rule out this possibility. In 2 patients, well demarcated abnormal soft-tissue masses were demonstrated by orbital pneumotomography (Figs. 7 and 8). At operation the tumor, in each instance, proved to be of the size, shape, and position indicated in the pneumotomograms. Both of these tumors were completely removed and were found to be hemangiomas.

Another patient gave a history of multiple congenital hemangiomas and, more recently, an intermittent palpable mass and visible swelling just above the left globe. Orbital pneumotomography revealed a vague round abnormal density, about 1 cm. in diameter, in the anterior-superior medial quadrant of the orbit in approximately the same location in which the mass had been palpated. It was felt that this probably represented a hemangioma but, because of the questionable radiographic findings and lack of symptoms, surgery was not performed.

Two patients with unilateral exophthalmos, 1 of whom had localized papilledema of the optic disk, were found on orbital pneumotomography to have soft-tissue

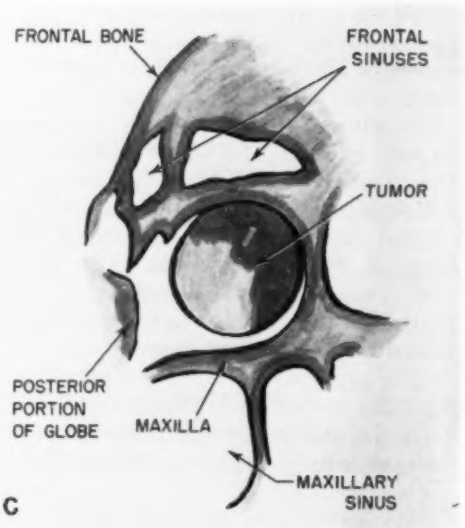

Fig. 7. C. Schematic drawing to illustrate tumor as seen on lateral section.

tumors contiguous to the optic nerve. Both tumors are considered to be either optic-nerve or nerve-sheath tumors. These 2 patients are being followed and, if necessary, surgical removal of the tumors will be undertaken.

In a patient with rather sudden onset of unilateral exophthalmos, no tumor was

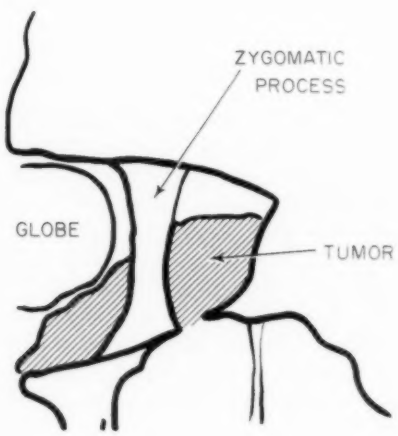

Fig. 8. Lateral tomogram, with schematic drawing, showing a large soft-tissue tumor just posterior and inferior to the globe.

found on orbital pneumotomography. A pseudo-tumor was considered to be responsible for the exophthalmos, and treatment with ACTH was followed by complete return to normal within two weeks. In still another case of unilateral exophthalmos—in a child of five years—no retrobulbar abnormalities could be demonstrated by orbital pneumotomography. Surgical exploration revealed a fibrous tissue mass in the anterior-superior medial portion of the orbit. No tumors were revealed in the remaining cases.

CONCLUSION

Orbital pneumotomography is of greatest value in cases of unilateral exophthalmos in which an orbital tumor is suspected. Orbital exploration without localization is often a traumatic and unproductive procedure. Induction of emphysema combined with body-section radiography is not only useful in establishing the presence of a tumor without the necessity of a major operation but also in determining the exact location of the tumor. The surgeon is thus enabled to plan his surgical approach to the best advantage.

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SUMARIO

Neumotomografía Orbital

Descríbese una técnica que combina el empleo de aire retrobulbar con la radiografía seccional, que los AA. denominan neumotomografía orbital. Este procedimiento no sólo ayuda a revelar los tumores del tejido blando anormal en el espacio retrobulbar sino que también localiza y demarca los bordes de los mismos, considerándose en este sentido superior a los métodos radiográficos corrientes.

El método fué empleado en el Centro Médico de Cornell en Nueva York en 12 casos de exoftalmía unilateral, en los que se sospechaba tumor o se consideraba necesario eliminar esa posibilidad. En 5 casos con hallazgos positivos, había tumor (1 incomprobado). En 1 caso con hallazgos negativos, parecía que existía un seudotumor y en otro la exploración quirúrgica reveló una tumefacción de tejido fibroso. En los casos restantes, se excluyó el diagnóstico de tumor.

Air Insufflation of the Colon as an Aid in the Diagnosis of Cholelithiasis[1]

WALTER LENTINO, M.D.,[2] and DOMINICK J. PRINCIPATO, M.D.[3]

IN THE AVERAGE case, the diagnosis of cholelithiasis by radiographic methods presents no difficulty for the experienced roentgenologist. In some cases, however, troublesome shadows are cast by fecal material and air in the hepatic flexure of the colon. These radiolucent shadows, when they overlie the contour of the medium-containing gallbladder, can be mistaken for gallstones.

Ordinarily, the use of regular and special projections, as the postero-anterior with the patient erect and the right lateral decubitus advocated by Kirklin (1), will separate the shadows produced by the colon from those of stones within the gallbladder. In a small number of cases, however, the diagnosis of cholelithiasis will still remain in doubt. This occurs under two conditions:

1. When the shadow of the medium-filled gallbladder cannot be separated from that of the colon in *any* position. This can be due either to adhesions between gallbladder and colon or to the peculiar anatomic construction of the patient.

2. When the gallbladder shadows are actually separate from those produced by the colon, but the roentgenologist has difficulty in locating the exact confines of the colon. This is particularly apt to be troublesome if the gallbladder is poorly visualized. Vague radiolucencies within its outline become difficult to evaluate, especially when the adjacent colon shows similar radiolucent areas.

The purpose of this article is to suggest a method for the study of such cases. The procedure is not advocated as a routine measure. It is time-consuming, and somewhat inconvenient for the patient. It demands the technical services of a roentgenologist prior to radiography. It is therefore recommended only when routine cholecystographic methods are inconclusive.

METHOD

1. The preparation of the patient is precisely the same as for the routine cholecystographic examination. A tap water enema in the morning prior to reporting to the x-ray department is mandatory.

2. Routine views are taken. In our department, this includes a postero-anterior prone, a postero-anterior erect, and a left anterior oblique view.

3. A rectal tube is then inserted 2 inches beyond the anus, and a double-chambered bulb syringe of the type used for air-contrast studies of the colon is attached and inflated.

4. Under fluoroscopic observation, the entire colon is filled with air. Particular care is taken to insure that the ascending colon and hepatic flexures present a continuous column of air.

5. Repeat standard views are taken with the retention tube in place.

COMMENT

It would seem that the introduction of air into an organ whose air content is itself responsible for diagnostic difficulties is illogical. The real problem, however, has always been to determine the difference between irregular small air bubbles in the colon and the small radiolucencies in the gallbladder shadow cast by stones. With the introduction of air, the colon becomes apparent as a continuous radiolucent column, instead of multiple small pockets. This picture is easily identifiable and is

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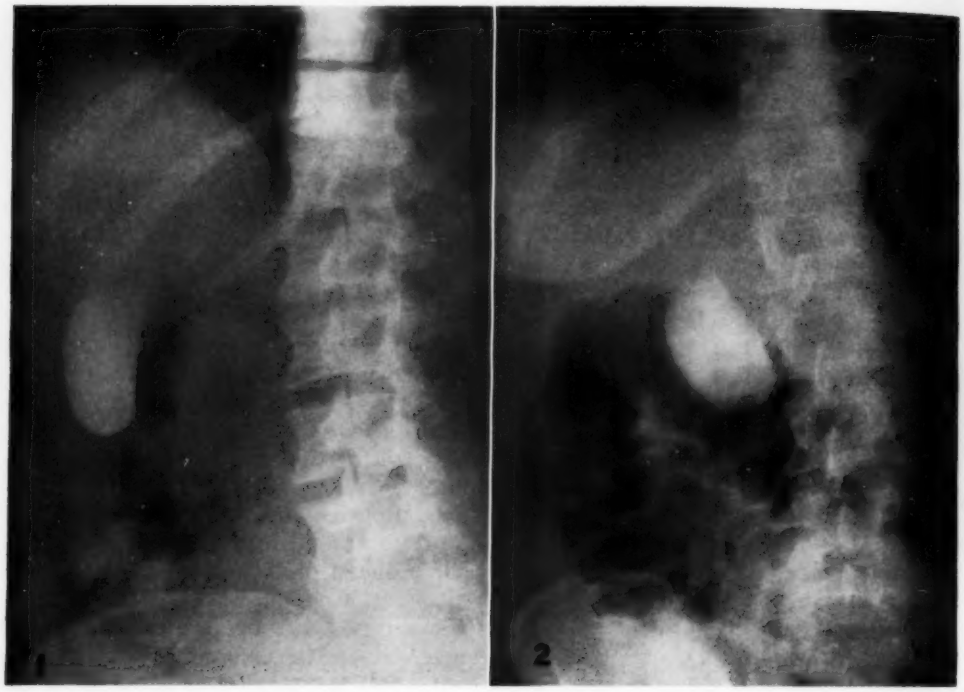


Figs. 1 and 2. Case I. 1. Two faint radiolucencies appear within the shadow of the gallbladder. Note the adjacent air within the colon.
2. Film taken after air insufflation of the colon, showing two sharply etched black calculi within the lumen of the gallbladder. They can readily be seen through the overlying colon, which by virtue of its increased air content serves as a window.

readily differentiated from that produced by gallstones.

The idea of using an artificially produced air-filled viscus for the better demonstration of radiographic pathology is not new. Reports have appeared in both the radiographic and urological literature (2–4) describing the value of a dilated, air-filled stomach in permitting clearer visualization of the urinary collecting system in pediatric excretory urography. The use of air in the colon to aid in the diagnosis of cholelithiasis is previously unreported.

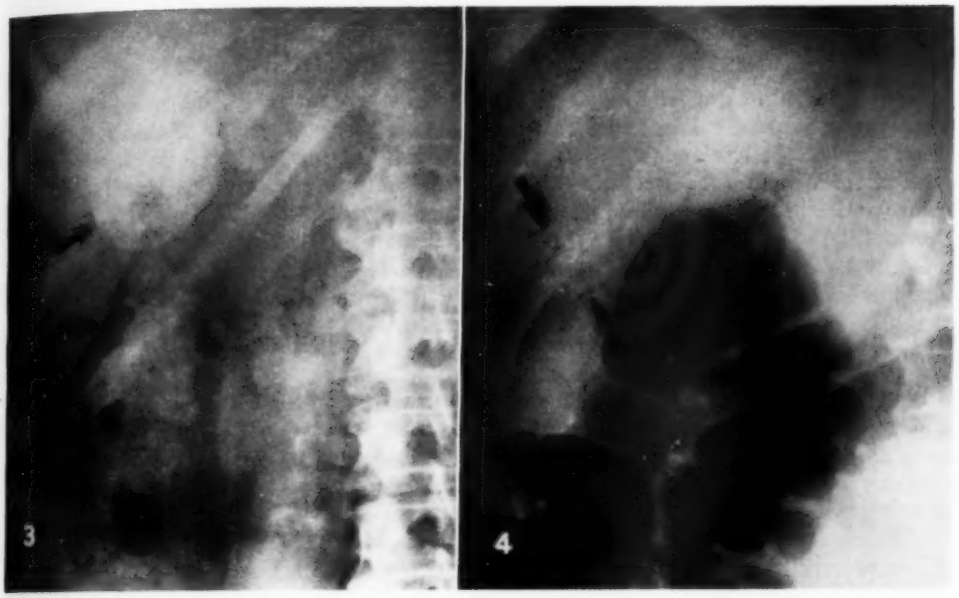
CASE REPORTS

CASE I. A 33-year-old Puerto Rican female was admitted to Bellevue Hospital with a two-hour history of severe generalized abdominal pain, nausea, and vomiting, and a three-year history of intolerance to fatty foods. Physical examination elicited splinting, tenderness, and rebound tenderness of the right upper quadrant.

A routine gallbladder series disclosed two faint radiolucencies within the gallbladder shadow. Opinion was divided as to whether these represented stones, because of the close proximity of air within the hepatic flexure (Fig. 1).

The colon was filled with air under fluoroscopic observation, and repeat films were taken (Fig. 2). The colon was seen to overlie the gallbladder in all projections. This did not impair the diagnostic quality of the films; in fact, this was enhanced. Two black diamond-shaped areas of radiolucency were strikingly evident within the contour of the gallbladder. They can readily be seen through the "window" produced by the air-filled colon.

The above case demonstrates one situation in which air insufflation combined with cholecystography can be of aid in diagnosis. When the shadow of the gallbladder and the shadow of the colon cannot be separated, introduction of a column of air into the colon will potentiate the radiolucent shadows of gallstones and produce an actual window through which the gallbladder may be studied.



Figs. 3 and 4. Case II. 3. Faint visualization of the gallbladder, with multiple radiolucencies superimposed on its shadow (upper arrow). Similar mottled radiolucencies are cast by the ascending colon and the hepatic flexure (lower arrows).

4. Following air insufflation the colon is visualized as a clearcut radiolucent column, unrelated to the gallbladder shadow. The mottled radiolucencies in its contour (seen between the arrows) must represent gallstones.

CASE II: A 40-year-old obese white female, was admitted to Bellevue Hospital because of the sudden onset of "acute indigestion." She gave a history of long-standing anorexia, belching, and the frequent passage of flatus.

A routine gallbladder series showed extremely poor concentration of the medium within the gallbladder, in which there were multiple faint radiolucencies suggesting the possibility of gallstones. This appearance seemed to be continuous, on all views, with mottled radiolucencies in the partially air-filled colon and hepatic flexures (Fig. 3).

The colon was filled with air under fluoroscopic observation, and repeat films were taken (Fig. 4). The vague mottling with the gallbladder shadow was seen to be entirely distinct from, and beyond, the confines of the air-filled column of air representing the colon. The patient was operated upon, and the diagnosis confirmed.

SUMMARY

1. An accessory technic to be used in conjunction with cholecystography in difficult cases is described. The method consists of instillation of air into the colon under fluoroscopic control prior to ordinary cholecystography.

2. The value of this method is stressed in the following circumstances: (*a*) when the colon shadow cannot be separated from that of the medium-filled gallbladder in spite of the use of all conventional and special projections; (*b*) when uncertainty exists as to the exact location of the colon.

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(Para el sumario en español, véase la página siguiente.)

SUMARIO

La Insuflación Aérea del Colon como Auxiliar en el Diagnóstico de la Colelitiasis

Se describe aquí una técnica accessoria para empleo junto con la colecistografía en casos difíciles. El método consista en la insuflación de aire en el colon bajo gobierno fluoroscópico antes de la colecistografía habitual.

Recálcase el valor de este método en las siguientes circunstancias: (a) cuando no puede separarse la sombra del colon de la de la vesícula biliar a pesar de usarse todas las proyecciones convencionales y especiales y (b) cuando reina incertidumbre con respecto a la localización exacta del colon.

Preséntanse 2 casos en que se empleó con éxito el procedimiento.

The Effect of Cholecystostomy Upon Subsequent Roentgenologic Appearance of the Gallbladder[1]

JOHN A. LAYNE, M.D.

THIRTY-FIVE, twenty-five, and even twenty years ago a considerable number of physicians and surgeons regarded cholecystostomy as preferable to cholecystectomy for chronic disease of the gallbladder. Inasmuch as present criteria for either operation differ considerably from those held previously (due to the availability of antibiotics and the development of improved anesthetic and operative procedures, as well as the fact that patients now avail themselves of medical care earlier), it is believed that there will be few opportunities in the future to study any appreciable number of patients in whom cholecystostomy has been followed, after a significant period of time, by cholecystography.

MATERIAL AND METHODS

This study presents the results of cholecystography in a series of 38 patients who had previously undergone cholecystostomy. In almost all instances, the operation had been performed originally for acute cholecystitis or empyema of the gallbladder. In none of these cases was it done as an elective or interval procedure. Thirty-four of the 38 patients were females; 4 were males. In 28 instances, gallstones were present at the time of cholecystostomy. Drainage of the gallbladder was continued up to six weeks postoperatively, the average time being ten days.

Cholecystograms were obtained from four months to forty-three years after operation, the average interval being 15.6 years. Cholecystography was performed in the usual manner and in almost all instances Priodax was the contrast agent. Where the gallbladder was not visualized, the examination was repeated. In only 7 cases were cholecystograms taken prior to the cholecystostomy available for comparative studies.

RESULTS

Normal cholecystograms were obtained in only 11 of the 38 individuals (29 per cent) who were examined radiologically following cholecystostomy. In 10 additional patients a normal concentration of the gallbladder medium was present in the viscus but calculi could be clearly demonstrated. In 17 persons visualization of the gallbladder was not obtained, and in 6 of these radiopaque calculi were seen. No correlation was noted between the results of cholecystography and the interval between that examination and cholecystostomy or the age or sex of the patient. Since 27 of the 38 patients (71 per cent) examined had evidence of disturbed gallbladder function, it may be concluded that the performance of cholecystostomy, for relief of acute inflammation of the gallbladder, in the hope that drainage of the viscus will result in a return to normal function, is not justified.

Of the 28 patients in whom gallstones were present at the time of cholecystostomy, 8 had a normal cholecystogram. In the remaining 20 (71 per cent), evidence of disturbed gallbladder function was observed. In 6 of the latter group there was good visualization and calculi were demonstrated. Calculi were present also in 6 of 14 patients in whom the gallbladder was not visualized. Inasmuch as 71 per cent of the entire group showed signs of disturbed gallbladder function following cholecystostomy, it may be concluded that the presence of gallstones at the time of cholecystostomy apparently

[1] From the Department of Medicine, Great Falls Clinic, Great Falls, Montana. Accepted for publication in February 1955.

TABLE I: COMPARISON OF THE ROENTGEN APPEARANCE OF THE GALLBLADDER BEFORE CHOLECYSTOSTOMY WITH ITS APPEARANCE AFTER OPERATION IN 7 INDIVIDUALS

Before Cholecystostomy	After Cholecystostomy (years later)
1. Good visualization + calculi	Good visualization + calculi (21 years)
2. Good visualization + calculi	Good visualization + calculi (11 years)
3. Good visualization + calculi	Normal visualization, no calculi (11 years)
4. Not visualized	Not visualized (4 months)
5. Not visualized	Not visualized (8 years)
6. Good visualization + calculi	Good visualization + calculi (9 years)
7. Not visualized, calculi present	Not visualized, calculi present (14 years)

does not predispose to a greater incidence of gallstones or disturbed gallbladder function after the operation.

In 7 patients it was possible to compare the results of cholecystography before cholecystostomy with the roentgen appearance of the gallbladder years later (Table I). In only 1 of the 7 was there a difference in pre- and postoperative cholecystograms.

DISCUSSION

It is now generally agreed that cholecystostomy should be reserved for those instances of acute inflammation of the gallbladder requiring operation in which there exist distinct contraindications to the longer procedure of cholecystectomy. Certainly cholecystostomy has little place in the surgical management of chronic gallbladder disease. Surgeons and internists alike have arrived at this conclusion on the basis of clinical experience with many patients who, having undergone cholecystostomy, required subsequent cholecystectomy. In view of this, it is of interest that so few studies similar to the present one are to be found in the literature.

Spurling and Whitaker (1), in 1927, reported a series of 12 cases with cholecystostomy and subsequent cholecystography. The interval between operation and cholecystographic study in their series averaged six and a half years and ranged from twenty-five days to nineteen years. None of the cholecystograms showed normal gallbladder shadows. Four of the 12 patients experienced a recurrence of calculi. The authors concluded that drainage of a diseased gallbladder in the expectation that it will regain its normal function was a futile procedure as well as one endangering the future health of the patient.

Jenkinson and Foley (2), in 1936, studied 28 patients who had undergone cholecystostomy eight months to twenty years (average seven years) before cholecystography. Of that number, 19 or approximately 68 per cent showed a normally functioning gallbladder. In 2 of the 28 patients the gallbladder filled and emptied normally but stones were present.

CONCLUSIONS

1. Normal cholecystograms were obtained in only 11 of 38 individuals (29 per cent) who were examined roentgenologically an average of 15.6 years after cholecystostomy performed for acute inflammatory disease of the gallbladder. In the remaining 27 patients (71 per cent), either the gallbladder was not visualized or calculi were demonstrable.

2. The performance of cholecystostomy for the relief of acute inflammation of the gallbladder, in the hope that drainage of this viscus will result in a return to normal function, is not justified.

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SUMARIO

El Efecto de la Colecistostomía sobre el Subsiguiente Aspecto Roentgenológico de la Vesícula Biliar

En una serie de 38 personas sometidas antes a la colecistostomía hubo ocasión de observar los resultados de la colecistografía. No se obtuvieron colecistogramas normales más que en 11 de las 38 (29 por ciento) que fueron examinadas en un promedio de 15.6 años después de haberséles ejecutado la colecistostomía. En los 27 enfermos restantes o no se visualizó la vesícula biliar o se observaron cálculos.

Estos hallazgos confirman la opinión, abrigada hoy día generalmente, de que no está justificada la ejecución de la colecistostomía para el alivio de la colecistitis con la esperanza de que el drenaje dé por resultado el retorno de la función normal.

On the Role of Radiothorium (Th^{228}) in Radium Poisoning

M. A. VAN DILLA, Ph.D., and B. J. STOVER, Ph.D.

THE WORK THAT we shall report is part of a long-term study of the chronic toxicity of plutonium deposited in the skeleton. Toxicity in man is the objective of our investigation but, since man cannot be used as an experimental subject, our work has been done with the dog (beagle), whose skeletal system approximates the human for our purposes.

The strategy is to compare the effects of plutonium (Pu^{239}) with radium (Ra^{226}). There is now available a considerable body of knowledge on chronic radium poisoning in man. By combining the dog data on radium and plutonium with the human radium data we should be able to extrapolate to human plutonium poisoning.

A complicating factor has recently become prominent in considering the human data. What has been called "radium poisoning" has frequently involved poisoning by mesothorium (Ra^{228}) and/or radiothorium (Th^{228}) also. These radioactive materials are the only two long-lived daughters of the thorium series. Like radium, they are deposited chiefly in bone. We now know that they have played an important part in many cases of "radium poisoning" on which present-day tolerance levels are based.

Although these radioelements emit alpha, beta, and gamma rays, the alpha radiation is most damaging to tissue. All the alpha rays involved in the Ra^{228} decay to stable Pb^{208} follow the Th^{228} decay. Th^{228} produces one alpha ray, and its short-lived daughters produce four. Hence, with RdTh (Th^{228}) deposits in bone, we have to know whether the daughter products stay put or wander elsewhere in the body, if we are to calculate the total alpha energy delivered to bone.

This situation is analogous to the more familiar case of radium deposited in bone. In this case the first daughter product is 3.8-day radon, an inert radioactive gas of which roughly 50 per cent is exhaled by man. This exhalation represents alpha energy which harmlessly escapes from the body.

In our experiments, Th^{228} in radioactive equilibrium with its daughters was injected intravenously. The injection material consisted of the carrier-free radioisotopes in a citric acid-sodium citrate buffer solution of pH about 3.5. With this method of administration, 80 to 90 per cent of the injected Th^{228} is quickly deposited in the skeleton and remains there for the first six to nine months following injection. We find, however, that this is not true for the daughter products.

The first daughter product is 3.6-day ThX (Ra^{224}). It is formed at the sites of Th^{228} deposition in bone and enters the circulation. It then behaves like intravenously injected radium, part being excreted and part deposited in bone in a calcium-like pattern. This process goes on continuously and results in a Ra^{224}/Th^{228} ratio in bone of about 0.6. Hence, about 40 per cent of the Ra^{224} produced in the Th^{228} decay is excreted and fails to irradiate the skeleton.

The daughter product of Ra^{224} is thoron, an inert radioactive gas (an isotope of radon) with a 54-second half-life. In spite of this short half-life, appreciable thoron escapes from its parent Ra^{224} deposits in bone. This thoron enters the circulation; some of it decays to 10.6 hour ThB (Pb^{212}) in the blood and some is exhaled. Our measurements to date show that 10 to 15 per cent of the thoron produced leaves its site of formation in bone; roughly half decays in the blood (the resulting Pb^{212} at-

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[1] From the Radiobiology Laboratory, College of Medicine, University of Utah, Salt Lake City, Utah. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

taches to the red blood cells), while the other half is exhaled.

If we combine the above experimental findings with the energies involved in the alpha-transitions, we can estimate the fraction of the total alpha energy produced that is actually delivered to the bone. This fraction* is

$$\frac{5.4 + 0.6\,[5.6 + 0.85\,(6.3 + 6.8 + 7.9)]}{5.4 + 5.6 + 6.3 + 6.8 + 7.9} = \frac{19.5}{32} = 0.61$$

The alpha energy delivered to bone per Th^{228} disintegration is then 19.5 Mev, as compared with 5.15 Mev for plutonium and 8.6 Mev for radium (due to 80 per cent radon exhalation in beagles).

Thus it is apparent that, while Th^{228} is tightly bound to bone, the amount of its daughters escaping is such that 61 per cent of the alpha energy produced actually irradiates bone. It is also clear that Th^{228} delivers over twice the alpha energy to bone that results from equal activity of radium or plutonium. Hence, we should expect Th^{228} to be more toxic than either radium or plutonium in the first six to nine months after injection.

At present we are extending our observations to longer periods of time. We are also studying dogs which have been injected with mesothorium (Ra^{228}) free of Th^{228}, the purpose being to compare the metabolism of Th^{228} and its daughters formed from Ra^{228} deposits in bone to the present case of Th^{228} injected intravenously.

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* Here we assume that when 10.6-hour Pb^{212} decays in the blood, its daughter products also fail to irradiate the bone (preliminary data suggest that the 1.0 hour Bi^{212} rapidly moves out of the red blood cells and into the urine).

SUMARIO

El Papel del Radiotorio (T^{228}) en el Envenenamiento por Radio

El trabajo actual forma parte de un estudio a largo plazo de la toxicidad crónica del plutonio y del radio depositados en los esqueletos de perros. Por medio del uso de datos humanos acerca de la toxicidad del radio, resulta posible extrapolarse a la toxicidad del plutonio en el hombre. Sin embargo, un factor complicante en muchos casos de envenenamiento humano por "radio" ha sido la presencia a la vez de mesotorio (Ra^{228})y/o radiotorio (T^{228}).

Se han llevado a cabo observaciones del metabolismo del T^{228} y sus derivados en sabuesos adultos consecutivamente a la inyección de dicha substancia en una solución tope de ácido cítrico-citrato de sodio. Aproximadamente 80 a 90 por ciento del T^{228} inyectado en esa forma se depositó rápidamente en el esqueleto y permaneció allí durante los primeros seis a nueve meses. Sin embargo, el Ra^{224} de 3.6 días formado por la descomposición del T^{228} en el hueso pasa a la circulación; aproximadamente 40 por ciento se excreta y aproximadamente 60 por ciento se deposita en los huesos. También se desprende parcialmente del hueso torón, derivado del Ra^{224}. Aproximadamente de 10 a 15 por ciento del torón producido en el hueso pasa a la circulación; toscamente la mitad se descompone en la sangre mientras que se exhala la otra mitad.

La fracción de la energía alfa total que se lleva al hueso es, pues, 19.5 Mev/32 Mev, o 0.61. La energía alfa llevada al hueso por la desintegración del T^{228} es 19.5 Mev, comparada con 5.15 Mev para el plutonio y 5.6 Mev para el radio (debido a la exhalación de 80 por ciento de radón en los sabuesos). Por lo tanto, cabe esperar que el T^{228} sea la más tóxica de las tres substancias en los primeros seis a nueve meses consecutivos a la inyección.

(For Discussion of this paper see following page.)

DISCUSSION

James S. Robertson, M.D. (San Francisco): Some of the discussion that would be pertinent to this paper has already been covered in Dr. Marinelli's paper.[1] Since the tolerance levels for plutonium are calculated on the basis of animal experiments and on established radium toxicity in man, unless the radium calculations are correct, then the plutonium tolerance level will be wrong. It is not clear how much the thorium calculations would actually affect our criteria for the standard of radium or plutonium tolerance levels, but at least this is a step toward refining these concepts.

Dr. Van Dilla mentioned that he injected a mixture of the thorium in equilibrium with its daughter products. I think it would be of some interest to separate these daughter products individually to really distinguish between what happens to the injected or ingested mixture, and what happens to that which is formed *in situ*. In particular, the thoron can be obtained and handled as a gas, despite its short half-life. The technic of handling has been described by Hevesy and Alexander.

I would like to ask whether the estimate of thoron that is exhaled from the lungs is based on measurements of exhaled gas, because the gas which gets into the lungs is not instantaneously excreted. The lungs do have a finite "wash-out" time which is comparable to the half-life of the thoron gas. This might lead to too high an estimate of the amount that is left in the bone.

Another question is: Have any more attempts at radioautography been made? Does Dr. Van Dilla have any data—or speculation—on the role of radiothorium in the chronic effects of radium?

Dr. Van Dilla (*closing*): We have been measuring thoron by trapping it on charcoal and measuring the gamma-rays from the Pb^{212} daughters.

I think that our present tolerance level of radium in man might have to be changed materially if the dial workers and others ingested and retained radiothorium and/or mesothorium. The damage that we see after twenty to thirty years might be due in large part to skeletal deposits of either or both of these radioactive materials which have largely decayed away in the interim. Thus, it may be that radium (Ra^{226}) is not as toxic as we have thought.

We are very interested in the histologic distribution of these radioactive materials, and Dr. James S. Arnold is carrying out an excellent program of autoradiography at our laboratory.

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[1] Gustafson and Marinelli: A Spectrometric Method for the Study of Radon Partition in Radium-Burdened Animals. Radiology **65:** 90–94, July 1955.

A Study of the Effectiveness of Pyridoxine and Dramamine on Clinical Radiation Sickness[1]

ANNA SILVERMAN, M.D., MORTON M. KLIGERMAN, M.D., JOHN W. FERTIG, Ph.D., and KENT ELLIS, M.D.

THIS PAPER reports the results of a statistically controlled study of the effectiveness of two widely used drugs on radiation sickness. The drugs tested were pyridoxine, first advocated by Maxfield and his associates in 1943 (1), and Dramamine, advocated by Beeler *et al.* in 1949 (2). These were selected as representative of two groups of compounds commonly used in radiation sickness, namely, antimotion sedative-type drugs and vitamins.

Evaluation of whether or not a patient has radiation sickness is difficult because it is largely a subjective syndrome, the symptoms of which can be caused by many different processes, organic and psychologic, that may be active in those receiving radiation therapy. In addition, it is difficult to eliminate bias on the part of both patient and doctor in assessing the response to any medication for specific complaints.

In order to minimize errors due to these factors, the drugs and placebos used in this study were made up in identical appearing capsules and all patients were instructed to take them in the same manner throughout the course of radiotherapy. Capsules containing Dramamine, pyridoxine, and a combination of Dramamine and pyridoxine were tested against each other and against a placebo of milk sugar. The content of the capsules was known only to the hospital pharmacist until all observations, evaluations, and some of the statistical analysis had been completed. The physician treating the patient recorded the symptoms and an estimation of the general condition daily. At the conclusion of the study the records were reviewed for comparison of the effectiveness of the different capsules, on the basis of the number of patients with symptoms attributable to radiation sickness. The data were also analyzed according to the region of the body treated and according to the temporal patterns of symptoms, although this was not the prime object of the study.

METHOD

The following program was carried out over a one-year period.

Capsules: Four groups of capsules, identical in appearance, were prepared with contents as follows: No. 1, pyridoxine 25 mg. and Dramamine 50 mg.; No. 2, milk sugar (placebo); No. 3, pyridoxine 25 mg.; No. 4, Dramamine 50 mg.

Patients: All patients being treated definitively with deep x-ray irradiation (200 to 250 kv., h.v.l. 1.0 to 1.5 mm. Cu) on a daily basis were included in the study. Division into nine groups was made according to the planned site and duration of the treatment, as follows:

Treatment Period	Abdomen	Chest	Extremity
8–10 days	1	4	7
2–3 weeks	2	5	8
4–6 weeks	3	6	9

Assignment of Capsules: Within each of the nine groups, the patients were separately assigned one of the four types of capsules by a method of random rotation effected through the use of tables of random numbers; thus there were in effect nine small experiments. Each patient was instructed to take his capsule three times daily during the course of treatment, and was told that this was part of the treatment routine.

[1] From the Departments of Radiology and Biostatistics, College of Physicians and Surgeons, Columbia University, and the Radiologic Service of the Presbyterian Hospital, N. Y. Accepted for publication in February 1955.
Dramamine used in this study was supplied by the G. D. Searle Co., Chicago. Pyridoxine was supplied by the S. S. White Co., New York.

TABLE I: FREQUENCY OF RADIATION SICKNESS ACCORDING TO CAPSULE REGARDLESS OF TIME AND SITE

Capsule	Patients	1+	2+	3+	Total Sick
1. Pyridoxine 25 mg. plus Dramamine 50 mg.	44	19	4	1	24 (54.7%)
2. Milk sugar	46	17	4	1	22 (47.8%)
3. Pyridoxine 25 mg.	47	16	1	0	17 (36.2%)
4. Dramamine 50 mg.	48	19	3	0	22 (45.8%)
TOTAL	185	71	12	2	85 (46%)

Observation of Patients: After as casual questioning as possible, the physician actually treating the patient recorded daily on a special data sheet the following information:

1. Presence and severity of symptoms usually found in radiation sickness. The symptoms considered most important were anorexia, nausea, vomiting, malaise, prostration, headache, dizziness, and weight loss.

2. Doctor's estimate of whether symptoms were due to radiation sickness.

During the course of the investigation these observations were made by four different doctors. Differences among their interpretations were balanced out over the four treatment groups because of the rotation employed.

RESULTS

The data sheets were reviewed and the degree of radiation sickness was evaluated. For a diagnosis of radiation sickness, symptoms had to be present for at least two successive days and could not be attributable to other causes. Four grades were recognized— 0, 1+, 2+, and 3+, on the basis of the following criteria:

Grade 0: No symptoms of radiation sickness.

Grade 1+: General symptoms of radiation sickness, including very mild to moderate anorexia or nausea lasting more than one day without vomiting, significant decrease in food intake, or weight loss.

Grade 2+: Moderately severe anorexia and nausea causing decrease in food intake, vomiting in moderate degree on two or more days.

Grade 3+: Daily and frequent vomiting, marked weight loss, and severe prostration.

If, for any reason, there was a question as to whether a patient had radiation sickness, he was placed in the radiation sickness group. This affected the estimate of the true incidence of radiation sickness, but did not interfere with testing the effectiveness of a particular drug in reducing the frequency of symptoms. Since the patients were put into the several groups by random rotation, eventually the number of cases in these groups incorrectly diagnosed as radiation sickness would become equal.

Within each of the nine site-time groups, the number of patients assigned to each of the four capsules was not necessarily equal. In 6 cases, capsules were assigned but treatment was either not given or was discontinued for reasons other than radiation sickness. Four patients refused to take the capsules. In spite of these difficulties, the numbers taking each of the four capsules were approximately equal. The inequalities within the separate sub-groups did not interfere with the statistical analysis.

FREQUENCY OF SYMPTOMS

At the end of one year there were 185 patients in the series. A total of 85 (46 per cent) had had symptoms compatible with the diagnosis of radiation sickness. Although this was a relatively high frequency, the degree of sickness was mild (1+) in most of the cases. In only 12 patients (6.5 per cent) were the symptoms of 2+ severity, and in only 2 (1.1 per cent) was the grading 3+ (Table I).

COMPARISON OF DRUGS

The effectiveness of the drugs tested was judged by comparing the frequency of symptoms in the groups of patients re-

ceiving the different capsules. As shown in Table I, the incidence of radiation sickness for these groups was as follows: Capsule No. 1 (Dramamine and pyridoxine), 54.7 per cent; Capsule No. 2 (milk sugar), 47.8 per cent; Capsule No. 3 (pyridoxine) 36.2 per cent; Capsule No. 4 (Dramamine), 45.8 per cent. These differences in the frequency of radiation sickness are not statistically significant as determined by the use of the Chi square test. The probability of exceeding such differences by chance alone is close to 50 per cent. Comparisons of the four treatment groups for specific sites of treatment or for specific duration of radiation therapy reveal the same lack of significance in the capsule effectiveness. When the group of patients taking capsules containing Dramamine (Nos. 1 and 4) were compared with the groups receiving capsules without Dramamine (Nos. 2 and 3), no significant difference was found. The same comparison was made between the groups taking capsules with and without pyridoxine, and here again the difference was not significant. Comparison of groups 1 and 2 with groups 3 and 4 showed that the effect of one drug was not significantly different whether the other drug was present or absent.

TABLE II: FREQUENCY OF RADIATION SICKNESS ACCORDING TO SITE, REGARDLESS OF TIME AND CAPSULE

Area	Patients	1+	2+	3+	Total Sick
Abdomen	66	29	7	2	38 (57.6%)
Thorax	73	30	4	0	34 (46.6%)
Extremities	46	12	1	0	13 (28.3%)

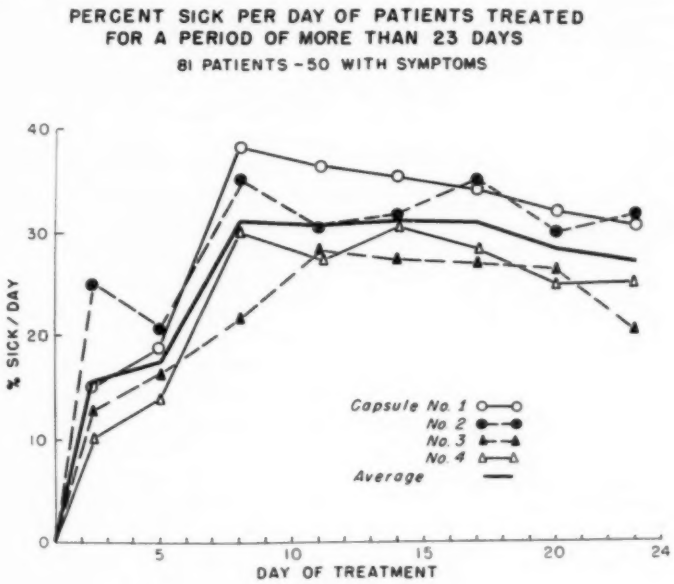

Figure 1.

The number of patients with radiation sickness of grades 2+ and 3+ was so small that comparison of the effectiveness of the different capsules in preventing severe sickness is meaningless; at any rate, the differences were not significant.

The similarity in the effectiveness of the four groups of capsules is demonstrated by the accompanying graph (Fig. 1), which shows the daily frequency of radiation sickness in patients treated for four to six weeks.

COMPARISON ACCORDING TO SITE TREATED

Table II shows the variation in incidence of radiation sickness with the region treated, without reference to the capsule given or the period of irradiation. These percentages differ significantly from one

TABLE III: FREQUENCY OF RADIATION SICKNESS ACCORDING TO SITE IN LONG-TREATMENT (FOUR TO SIX WEEKS) GROUPS

Area	Patients	1+	2+	3+	Total Sick
Abdomen	29	18	5	1	24 (83%)
Thorax	28	13	2	0	15 (53.6%)
Extremities	24	11	0	0	11 (45.8%)

another, even with adjustment for the different concentration of the various sites at the different time schedules. Table III gives the same information, *i.e.*, variations with site of irradiation, for patients treated four to six weeks. While the numbers here are small, the differences are just barely significant (probability, 1 to 2 per cent).

Of 14 patients who exhibited a more severe degree of radiation sickness (2+ or 3+), 9 received irradiation to the abdomen, 4 to the thorax, and only 1 to the extremities. The numbers, however, are too small to be of significance.

COMPARISON ACCORDING TO TREATMENT-TIME PERIODS

The distribution of patients according to the time period over which irradiation was given is shown in Table IV. Al-

TABLE IV: DISTRIBUTION OF PATIENTS ACCORDING TO DURATION OF TREATMENT

Time	Patients	1+	2+	3+	Total Sick
10 days or less	29	6	1	0	7 (27.6%)
11–23 days	75	23	4	1	28 (37.3%)
Over 23 days	81	42	7	1	50 (62.3%)

though a much higher incidence of radiation sickness was found in patients receiving long-term treatment—62.3 per cent for those treated longer than twenty-three days as compared with 27.6 per cent for those treated ten days or less—the groups are not really comparable. The relative number of patients treated over each of the three treatment areas differs from group to group. The group treated for less than ten days, for instance, has a relatively large number of head, neck, or extremity cases, for which in general smaller and fewer portals are used.

PATTERNS OF SICKNESS

Certain patterns of radiation sickness were noted in the course of this study, regardless of the type of capsule given. In general a latent period was followed by the development of symptoms on the third to the eighth day of treatment. Of 67 patients treated over the thorax or abdomen for more than eleven days who developed radiation sickness, only 14 showed symptoms before their second treatment. The accompanying graph shows a rise in the percentage of patients sick on each treatment day, with the peak on the eighth day. In a few instances, the latent period exceeded eight days, extending up to eighteen days.

One pattern frequently observed was as follows: After a short latent period (one to seven days), radiation sickness symptoms appeared, lasting for three to eighteen days (usually seven to ten days), after which the patient became asymptomatic even though x-ray therapy was continued. This pattern was seen in 14 of 39 patients treated over the thorax and abdomen for more than twenty-three days. The same pattern was noted in 11 of 27 patients similarly treated from ten to twenty-three days.

In a second pattern an initial latent period was followed by radiation sickness which continued throughout the remainder of the course of radiotherapy. This pattern was seen in 15 of the 39 chest and abdomen cases treated over twenty-three days and in 12 of the 27 treated from ten to twenty-three days.

Variable patterns were observed in the remainder of the series, with intermittent symptoms during the course of therapy.

DISCUSSION

All the patients in this series were handled in a similar fashion. By giving capsules of identical appearance to all patients including controls, throughout the course of radiotherapy, the psychic element which might influence response to a specific remedy was eliminated. The personal bias of the observers was also

eliminated, by keeping the number and the content of the capsules unknown until after all observations had been completed and the results evaluated. The composition of the four treatment groups was controlled with respect to site and time by random rotation of the four capsule preparations within each of nine site-time groups.

Although radiotherapy programs for different patients varied as to port size and daily integral dose, the different plans were equally represented in each of the four capsule groups. Small differences in the frequency of radiation sickness noted in the different groups are not statistically significant and may be due to chance differences in patient susceptibility.

Most of the patients suffering from radiation sickness had mild symptoms: only 12 had Grade 2+ symptoms, and only 2 Grade 3+ symptoms. In no case did it become necessary to discontinue treatment because of radiation sickness. Mild symptoms may be overlooked if careful daily observation of the patient is not carried out. In general, these symptoms do not interfere with the planned treatment. They are therefore not regarded by many radiologists as constituting radiation sickness, and it is agreed that they require no treatment. Consideration of even minimal symptoms, however, is important in evaluating the effectiveness of treatment of radiation sickness.

SUMMARY

A statistically controlled clinical study of the effectiveness of Dramamine and pyridoxine on the course of radiation sickness is reported. The group, studied over a period of one year, included 185 patients receiving deep x-ray therapy.

No significant differences were found in the frequency or duration of symptoms attributable to radiation sickness in groups of patients receiving pyridoxine, Dramamine, or a placebo.

NOTE: The authors wish to acknowledge the assistance of Drs. Joseph M. Moynahan, E. Finch Parsons, and Samuel H. Madell in the daily observation of patients.

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SUMARIO

Estudio de la Eficacia de la Piridoxina y la Dramamina en la Enfermedad Irradiatoria Clínica

Preséntanse un estudio clínico comprobado estadísticamente de la eficacia de la Dramamina y la piridoxina en la evolución de la enfermedad por irradiación. El grupo comprendió 185 enfermos que recibían roentgenoterapia profunda.

En el estudio usáronse cuatro formas de tratamiento: se comprobaron cápsulas que contenían Dramamina, piridoxina y una combinación de Dramamina y piridoxina en mutua oposición y frente a un placebo de lactosa. Todas las cápsulas administradas eran idénticas en aspecto, sin que conocieran su veradadero contenido ni los enfermos ni los observadores, por creerse que se reducirían así al mímino los errores dimanantes del prejuicio preexistente. Se analizaron los datos en relación con el número de enfermos que manifestaban síntomas imputables a la enfermedad por irradiación, conforme a la región del cuerpo tratada y de acuerdo con el patrón cronológico de los síntomas. Los planes terapéuticos para diversos enfermos variaron en cuanto a tamaño de la puerta y dosis integral diaria, pero estuvieron representados por igual en cada uno de los cuatro grupos de cápsulas.

No se descubrieron diferencias de importancia estadística en la frecuencia o la duración de los síntomas imputables a la enfermedad por irradiación en los distintos grupos de enfermos que recibieron piridoxina, Dramamina o placebo.

Experiments in the Photographic Monitoring of Stray X-Rays

Part I. General Considerations. The Choice of Film-Calibrating Radiations in Roentgen Therapy at 220 kvp and 1,000 kvp[1]

R. B. WILSEY, M.A., D. H. STRANGWAYS, B.A.[2] and G. M. CORNEY, B.A.

A PREVIOUS PAPER (13) reported the principal findings of the study upon which this paper is based, with the resultant recommendations on methods of film monitoring. The present account describes the experimental procedures employed, offers additional data, and discusses further some of the practical phases.

PHOTOGRAPHIC MEASUREMENT TECHNIC

The photographic measurements in this investigation involve the quantitative comparison of radiation intensities. The basic principles of such measurements have been previously described in detail (12).

Two radiations are judged to be of equal intensity photographically when they produce the same density on the film in the same time of exposure. With direct exposures of x-rays or gamma rays, the *reciprocity law* is found to hold, that is, a given exposure, defined as the product of the intensity and the exposure time ($I \times t$), will produce the same photographic effect regardless of the individual values of I and t. Thus, the ratio of two radiation intensities can be determined as the inverse ratio of the exposure times required to produce the same photographic density.

The photographic reciprocity law for direct x-ray exposures has been found valid by Morgan (8) and others for exposure times up to several hours, so that it can be relied upon in experiments such as those of this investigation. In the use of films for monitoring stray radiation, however, the total exposure period may occupy a week or more, recording very faint, variable, and intermittent intensities of radiation. The validity of photographic integration of such exposures has not been studied systematically. In the present investigation, a comparison was made between one set of Kodak Industrial X-ray Films, Type K, exposed to 20 mg. of radium for 14.17 hours and a similar set exposed to 1 mg. of radium for 20 times as long, or 11.8 days, with the same location and geometric arrangement. The film densities were closely similar for the two conditions of exposure. In another test, some Type K Films were set up in a diagnostic x-ray room and left to record the stray radiation over a period of three days. Adjacent pocket chambers were read at the close of each day and their exposures were added for the three-day period. The total exposures evaluated by the films and by the chambers showed excellent agreement. This subject deserves further investigation, but the probabilities are that with exposures to x-rays or gamma rays the reciprocity law is substantially valid for periods of one or two weeks, perhaps longer.

Other phenomena which may affect the validity of photographic measurements over an extended period are growth and fading of the latent image. McLaughlin and Ehrlich (7) have reported tests of latent-image fading on six photographic materials used in photographic dosimetry. Four of the samples, including two types of radiographic film, showed only a slight fading during an eight-day period. A contact-printing paper suffered a 20 per cent loss in density, while Kodak Spectroscopic Film, Type 548-O, showed a 60 per cent loss in eight days. Spectroscopic Film, Type 548-O, has extremely fine grain and, because of its very low speed, has been used for recording massive doses of radiation. It is apparent that its use for this purpose should be confined to exposures of less than two hours, and that the

[1] Communication No. 1719 from the Research Laboratories, Eastman Kodak Co., Rochester, N. Y.
[2] Deceased.

film should be processed shortly after exposure.

It is to be expected that, under reasonably good ambient conditions, *i.e.*, temperatures below 80°F. and a relative humidity of less than 50 per cent, latent-image growth or fading will be quite slow and that no serious error will be experienced from this source with exposure periods up to two weeks or more.

At temperatures up to 100° F., the keeping properties of unexposed film are usually quite good, provided relative humidity does not exceed 50 per cent. When, however, higher humidity is combined with the higher temperatures, deterioration is apt to be more rapid, particularly in the matter of increased fog. If monitoring films are to be exposed under such conditions, it is highly desirable that films to be used for calibration exposures be stored under similar conditions until the time of exposure, and that they be processed with the monitoring films.

In measuring quantities of radiation, if exposures on two areas of a film have produced different densities, the relative values of these exposures can be derived by reference to a graded series of exposures, either on the same film or on a similar film developed with it. A convenient device for producing such a graded series of exposures is the x-ray sensitometer. In its most common form, a lead disk containing a series of angular openings is rotated at constant speed over the film; through these openings, the film is exposed to the x-ray beam, held at constant intensity, for a series of times. The resulting film densities are plotted against either the exposure or the common logarithm of the exposure. The density-log exposure (D-log E) curve is called the characteristic, or sensitometric, curve. From such curves, densities can readily be converted into relative exposures.

As a rule, with radiations hard enough to affect the emulsions on both sides of the film about equally, the form of the sensitometric curve is independent of the quality of the exposing x-rays or gamma rays. Because of this, sensitometric exposures can be made with any convenient radiation, as for example 70-kv x-rays, for evaluating relative exposures on film exposed to any of the other radiations. The important precautions are that the sensitometric exposures should be made on samples of the same films that were used for the radiation measurements, and that the films carrying these two types of exposure should receive identical development.

In discussions of the relation between photographic density and x-ray exposure, reference is sometimes made to the following equation derived by Pelc (9) on theoretical grounds:

$$D = D_m (1 - e^{-SE}),$$

where D is the film density produced by the exposure E; D_m and S are constants applying to a particular sample or type of film, and D_m represents the maximum density that can be produced on the film by sufficiently prolonged exposure and development. From a sensitometric standpoint, the coefficient S is a factor indicating the speed of the film.

According to this equation, the slope of the straight-line portion of the sensitometric curve (commonly called "gamma" or γ) should bear a fixed ratio, namely 0.85, to the maximum density, D_m. Furthermore, the dimensions of any x-ray sensitometric curve could be derived from any other by multiplying all the density values by a constant factor.

In the experimental determination of the sensitometric curve, D_m is rarely included, since it is of little or no practical interest. Wilsey and Pritchard (14), however, have reported such curves for four types of film, each with a wide range of times of development. A review of their data shows that the properties predicted by the Pelc equation apply, even approximately, to only a few of the total number of curves shown.

FILM-CALIBRATION PROCEDURES

The density produced on a monitoring film by stray radiation is evaluated, in terms of roentgens, by comparing it with

similar films (of the same emulsion number) which have received a known exposure (or series of exposures) to suitable radiation, measured by a roentgen meter, and have undergone the same processing.

If it is desired merely to determine whether the exposures recorded by the monitoring films exceed the maximum permissible dose for the period of the test, only this exposure need be applied to the calibration films. After the films are processed, visual comparison will give the required answer.

If an estimate, or measurement, of the exposures recorded by the monitoring films is desired, the calibration films should be given a series of exposures that will produce a wide range of film densities. After processing, each monitoring film is compared with the set of calibration films to find the closest match, which will indicate the approximate exposure. If a more accurate evaluation is required, the film densities should be measured with a densitometer. A curve is plotted of calibration-film density *versus* exposure, in roentgens, and the monitoring film exposures are then determined by reference to this curve.

A convenient means of impressing a series of exposures upon the calibration films is provided by a suitable sensitometer. The usual type, intended primarily for film testing, is designed to accommodate film strips several inches in length, but a row of dental films placed end to end will serve almost equally well.

Preferably, the design of the sensitometer should be suitable for use with the calibrating radiation. This is not always feasible, however, as when the only available sensitometer is designed for use with diagnostic x-rays, while the required calibrating radiation may be much harder, as for example the gamma rays of radium. As a rule, the form of the sensitometric curve, *i.e.*, the relation between density and log relative exposure, is substantially the same, with a given film, for various quantities of x-rays and gamma rays. The sensitometric exposures can be made, therefore, with any convenient radiation, such as diagnostic x-rays. In addition, several films are given a single known exposure to the required calibrating radiation (radium gamma rays assumed in this case). With the aid of the x-ray sensitometric curve, the differences in exposure between the monitoring films and the gamma-ray-exposed calibration films can be evaluated.

In a modification of this method, the relation between the gamma-ray exposure and the x-ray exposure (on the sensitometric scale) required to produce the same film density is first determined experimentally. For example, it might be found that the x-ray sensitometric exposures (in roentgens) should be multiplied by 20 to obtain their equivalent gamma-ray values. Thereafter, for the particular film batch or emulsion number, only the films exposed sensitometrically are used for calibration, and the monitoring films are evaluated in terms of the gamma-ray equivalent of the x-ray sensitometric exposure scale. This method was employed in the original application of the Type K lead-cross packets in monitoring the beta rays and gamma rays of uranium and the gamma rays of radium (13).

It has already been pointed out that the calibration films and the monitoring films should receive identical processing. The surest way of accomplishing this is to process them together, and to employ a suitable type of agitation during the development. The purpose of the agitation is to remove continuously the reaction products of development from the films and to mix them thoroughly with the developer so that its strength is kept uniform throughout its volume.

When the number of monitoring films is not large, the developer may be contained in the customary film processing tanks. Before each use, the developer should be stirred with a paddle to insure thorough mixing. The films may be agitated by hand. The top of the dental-film hanger carrying the films is grasped by the fingers, the films are immersed in the developer,

and the hanger is then moved in a variety of directions, *i.e.*, back and forth, up and down, in circular paths, throughout the period of development. Two dental hangers can be held by each hand in such a way as to avoid contact between films. If more hangers need to be used at a time, a suitable frame or clamp could be constructed to hold them.

If large numbers of films are to be processed, consideration may well be given to the method devised by Jones, Russell, and Beacham (5). Their equipment was designed for sensitometric film strips, but could be modified to accommodate dental x-ray films. The agitation is produced by metal blades, set perpendicularly to the plane of the films and moved back and forth at uniform speed past the films. This device produces a vigorous churning of the developer over the emulsion surface, while at the same time a circulation system provides a slow vertical flow of the developer. Tests showed this method to produce a high degree of uniformity of development, and to avoid the streaking of the film which has often accompanied mechanical methods of agitation.

When calibration films are processed along with each group of monitoring films, it is unnecessary to maintain close control of development conditions, as long as the agitation is sufficient to provide equal development of all the films. It is desirable, of course, to follow the processing conditions recommended for the particular films, such as type of solutions, time and temperature of development, and time of fixation. Other factors, however, can produce development differences which are troublesome from the standpoint of radiation measurement. For example, developer solutions made up from the same chemicals and by the same mixing procedure may show appreciable differences in development activity. A highly accurate standardization of degree of development is well beyond the scope of most photographic processing laboratories, and for that reason it is generally advisable not to attempt such a standardization, but rather to process the monitoring films and associated calibration films together, with equal and adequate agitation.

It is well to point out that the reliability of film-calibration exposures depends upon the accuracy of the r-meter with which they are measured. If local facilities for checking the calibration of the r-meter are not available, arrangements for such a check can usually be made with the manufacturer of the instrument.

In making the film-calibration exposures, sources of stray radiation should be reduced to a minimum. To accomplish this, the primary x-ray beam should be diaphragmed to a small size, but should be kept large enough to cover fully the ionization chamber or film. In this way, secondary radiation from a wall or from other material in the path of the beam will be minimized. Filters and diaphragms in the beam are sources of stray radiation and should be mounted at or near the tube portal. The ionization chamber or film should be placed well away—a meter or more—from the tube portal or any object (such as a wall) which is struck by the beam after it passes the chamber or film. Exposing the chamber and films at the same location will ensure that both receive the same radiation intensity, but if different distances must be used because of a considerable difference in sensitivity between chamber and film, the above precautions to limit stray radiation will minimize any deviations from the inverse-square law. The exposure timer may also require checking to ensure accuracy of timing.

ANGULAR VARIATION OF FILM SENSITIVITY

Since stray radiation may reach a monitoring film from any direction, it is important to know how the film response varies with the angle of the incident radiation. This was tested on dental film with 70-kvp x-rays filtered by 1 mm. of aluminum. The observed relative sensitivity as a function of angle of incidence is shown by the polar diagram of Figure 1. It is seen that

film sensitivity is diminished materially only for radiation making a small angle with the plane of the film. The increased path of this radiation through the film acts to lessen its influence upon the back emulsion, and this effect will naturally be less for harder radiation. It is concluded that the variation of film sensitivity with angle of incidence is not a significant factor in film monitoring. A similar finding is reported by Langendorff, Spiegler, and Wachsmann (6).

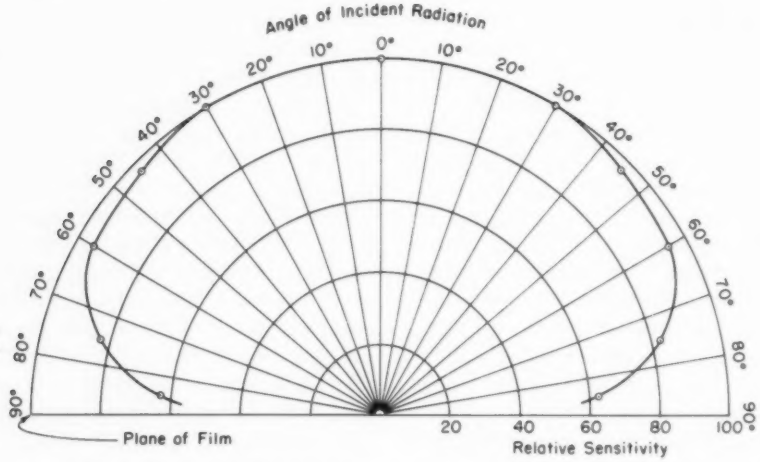

Fig. 1. Relative film sensitivity for 70-kv x-rays as a function of the angle of incidence of the radiation.

This conclusion does not apply if filters are mounted over the films. The use of such filters to determine the quality of the radiation can give only a rough estimate unless the radiation is received at a single, known angle of incidence. If filters are employed to compensate for the energy-dependence of film sensitivity, suitable allowance must be made for the resultant effect upon angular variation of sensitivity (13).

QUALITY OF SCATTERED RADIATION

The principal handicap of photographic film as a device for evaluating exposures to stray x-rays is the great variation in film sensitivity, in terms of reciprocal roentgens, observed as the photon energy or the quality of the radiation is changed (3, 4, 11, 13). This factor requires that adequate attention be given to the quality of the stray radiation to be measured, and that the choice of film-calibrating radiation be such as to avoid any undervaluation of the recorded exposure. The present report covers quality tests of the stray radiation occurring under various conditions, the resulting indication of the preferred film-calibrating radiation, and a comparison of the photographic and ionization evaluations of the stray radiation.

When a volume of light matter, such as tissue, is irradiated by a beam of primary x-rays, scattered x-rays emerge from this volume in all directions. Most of this emergent radiation has been scattered repeatedly, and different portions have undergone different degrees of filtration, depending upon the total distance in tissue each portion has traversed. The filtering action operates to harden the radiation, while the Compton scattering process operates to soften it. Because of the complexity of these phenomena, the quality of the scattered radiation, compared to that of the primary, is difficult to predict accurately and therefore is best determined by direct test.

The principal tests were made on the radiation scattered from water contained

in a tank of transparent Tenite plastic. The cross section of the tank was an oval 33 × 25 cm., corresponding to the dimensions of the average human trunk at the level of the anterior spine of the ilium as shown by Desjardins' *Anatomic Cross Sections of the Human Trunk*.[3] The height of the tank was 50 cm.

In all experiments of this type, special precautions were taken to prevent appreciable amounts of unwanted radiation from affecting the ionization chamber or film. When necessary, sufficient lead was added to the housing of the x-ray tube to avoid any effect of direct stray radiation. The top and bottom of the water phantom were covered with lead, as were parts of the sides when this did not interfere with the experiment. The ionization chamber, or film, was shielded by sheet lead from the x-ray tube portal and filter, and was also shielded from the major portion of stray radiation from the walls of the room.

As a convenient designation of the absorption of a filter for radiation, the term "absorption index" is adopted. This is defined as the common logarithm of the reciprocal of the x-ray transmission of the filter. Thus, if a filter transmits one-half of the radiation, the reciprocal is 2, and the logarithm is 0.30. Similarly, if the filter transmits one-tenth of the radiation, the absorption index is 1.0. This procedure is in accord with the practice of indicating the absorption values of an absorption curve on a logarithmic scale.

ROENTGEN THERAPY

In roentgen therapy at voltages of 200 kv and above, the normal and preferred procedure is to enclose the installation completely in a protective barrier. In this case, the only stray radiation to be tested is that transmitted through the barrier.

To correspond with the quality of this radiation, heavily filtered primary radiation should be used for calibrating the monitoring films. The filtration should be the maximum possible, consistent with reasonable times of exposure. In the present investigation, filtration as high as 14 mm. of copper was used with 220-kvp x-rays. Furthermore, the roentgenometer should be sufficiently sensitive to record the x-ray exposures within reasonable times of exposure.

At 1,000 kvp and above, the changes in film sensitivity are small, so that filtration of the primary beam is not important for purposes of calibration. Both sides of the film packet should be covered with a filter to absorb secondary electrons from external sources, such as the atmosphere or other near-by material. For 1,000-kvp x-rays 1 mm. of aluminum is adequate, whereas for the gamma rays of radium 0.5 mm. of copper or brass is required. With such filters on both sides of the film, back-scatter from the wearer's body is recorded on the same basis as stray radiation on the front of the film.

In a location where distance alone is relied upon for protection, and the purpose is to monitor the personnel or area in question, or if the construction is such that stray radiation can get around a protective barrier, the quality of the stray radiation is governed primarily by that emitted from the patient or specimen and the x-ray tube. To meet such situations, tests with the water phantom were made of the quality, intensity, and film evaluation of the secondary radiations occurring in therapeutic applications at 220 and 1,000 kvp.

The experimental arrangement is illustrated by the diagram in Figure 2, which shows a plan view as it would appear from a point vertically above. The primary x-ray beam is directed horizontally and the angles of scatter were measured from the forward direction of the central ray.

220-kvp Therapy: For comparisons of x-ray quality, the photographic absorption indices of 1.0 mm. aluminum, 0.25 mm. copper, and 1.0 mm. copper were determined for both the primary and the scattered radiations (Table I).

The higher indices for the scattered radiation at all three angles show all the scatter to be softer than the incident pri-

[3] New York, Paul B. Hoeber, 1924.

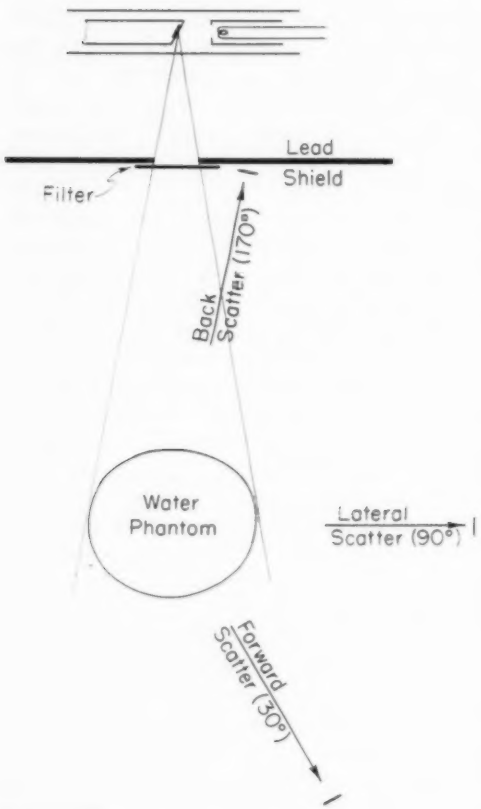

Fig. 2. Arrangement for testing the scattered radiation from a water phantom. Lead shielding, aside from that of the x-ray tube, is not shown.

mary radiation. Its quality lies between that of the unfiltered primary and the primary filtered by 0.5 mm. of copper. In this experiment, the full width of the phantom was exposed to the primary x-ray beam. Another test was made of the 90° scatter from a narrow primary beam 9 cm. wide and 15 cm. high at the center of the phantom. The resulting absorption indices are listed in the last line of Table I, and show the quality of the scattered radiation to be practically equal to that from the full width of the phantom. Thus, the use of a small field of primary radiation does not materially affect the quality of the 90° scatter.

The ratios of photographic to ionization evaluations of the scattered radiation are recorded in the last column of Table I. The values all exceed 1. Thus, the film as calibrated by the primary radiation overvalues the scatter, a feature which operates in the direction of increased safety.

Measurements of the intensity of the scatter at three angles with three field sizes were made with the Victoreen Proteximeter radiation meter, and are presented in Table II. These are to be compared with the direct stray radiation escaping through the x-ray tube shield.

The older recommendations of the National Bureau of Standards on *X-Ray Protection* (Handbook 15, May 16, 1931) specified a protective equivalent of 5 mm. of lead for the housing of a 225-kv therapy tube. Braestrup's (1) absorption curves give an output of 0.37 mr/ma-min. at 1 meter through 5 mm. of lead at 225 kvp. Our own observations on a different type of x-ray generator resulted in a value of 0.49 mr/ma-min. at 1 meter.

The more recent National Bureau of Standards Handbook (No. 41, March 30, 1949), *Medical X-Ray Protection up to Two Million Volts*, specifies a maximum of 1 r per hour of direct stray radiation when the tube is operating at its maximum rated current for its maximum rated voltage. Under this provision the direct stray radiation, as expressed in mr/ma-min. at 1 meter, will depend on the current rating of the tube. For comparison with the intensities of scattered radiation from the phantom, Table II includes the values of direct stray radiation through a tube housing of 5-mm. lead equivalent (N. B. S. Handbook 15) and for a 10-ma and a 30-ma therapy tube, as determined from Handbook 41.

If we consider only the scatter at angles of 90° or more, the film is found to overvalue it by a factor greater than 2 (Table I). In such a case, if the intensity of scattered radiation is at least equal to that of the direct stray radiation, the two radiations combined will still be fully evaluated, if not overvalued, by the film. If the "focus-skin" distance were different from the 50 cm. used in this experiment, the

TABLE I: QUALITY OF SCATTER FROM WATER PHANTOM AT 220 KVP, INHERENT FILTRATION 4-MM. AL

Type of Radiation	Added Primary Filter, (mm. Cu)	Angle of Scatter	Photographic Absorption Indices			Ratio Photographic to Ionization Intensity
			1.0 mm. Al	0.25 mm. Cu	1.0 mm. Cu	
Primary	1	...	0.03	0.09	0.27	1.0
Scattered	1	30°	0.03	0.14	0.42	1.1
Scattered	1	90°	0.03	0.15	0.51	2.1
Scattered	1	170°	0.03	0.15	0.52	2.4
Primary	0	..	0.05	0.27	0.64	..
Primary	0.5	..	0.02	0.08	0.36	..
Scattered (from narrow primary beam)	1	90°	0.03	0.16	0.52	..

TABLE II: INTENSITIES OF SCATTERED RADIATION AT 1 METER FROM CENTER OF WATER PHANTOM AT 220 KVP, 1-MM. COPPER ADDED FILTRATION, 50-CM. "FOCUS-SKIN" DISTANCE

Angle of Scatter	Mr/Ma-Min. for Field Area			Ratio of Primary Radiation on Surface of Phantom to Scattered Radiation for Field Area		
	25 *cm.*²	100 *cm.*²	350 *cm.*²	25 *cm.*²	100 *cm.*²	350 *cm.*²
45°	0.61	1.00	4.6	4740	2890	630
90°	0.30	1.42	6.2	9640	2030	466
125°	0.50	2.2	8.1	5780	1310	357
152°	0.55	3.2	9.1	5260	904	318

Primary Radiation Intensity at Surface of Phantom 2.89 r/ma-min. (in Air) for 100-cm.² Field

	Direct Stray Radiation in mr/ma-min. at 1 Meter	
Through 5 mm. lead	0.4–0.5	(N.B.S. Handbook 15)
10 ma tube	1.67	(N.B.S. Handbook 41)
30 ma tube	0.56	(N.B.S. Handbook 41)

radiation intensity at the surface of the phantom would be affected, with corresponding changes in the intensities of the scattered radiation. The use of a different x-ray generator might also alter the primary radiation intensity at the surface of the phantom or the patient. Under these conditions, the intensity of scattered radiation could be estimated by dividing the primary intensity at the skin, as measured in air, by the appropriate factor in the last three columns of Table II.

In practice, the patient may vary considerably in size from this phantom, and the x-ray tube voltage and filtration may differ from those used in obtaining these data. Table II, therefore, can be used only as a rough guide in estimating whether the scattered radiation exceeds the intensity of the direct stray radiation. Any doubt should be resolved in favor of the direct stray radiation, in which case the heavily filtered primary radiation should be used for calibrating the films.

Calculations made with the aid of Table I furnish a more precise guide to the choice of film-calibration conditions than the general recommendations listed in the original paper (13, pp. 233–234).

1,000-kvp Therapy: In their investigation of the protective requirements of 1,000-kv and 2,000-kv roentgen therapy installations, Braestrup and Wyckoff (2) found that the radiation scattered by a phantom at 1,000 kv was softer than the primary radiation by a degree to be expected from the Compton effect. In the present study, films calibrated by the primary radiation were found to overvalue considerably the radiation scattered by a water phantom, as shown in Table III. In these scattered radiation tests, the primary radiation covered a field about 20 cm. in diameter on the face of the phantom. In the test with primary radiation transmitted through the phantom, the field diameter was about 3 cm. The overvaluation of this radiation by the film indicates

TABLE III: PHOTOGRAPHIC EVALUATIONS OF PRIMARY X-RAYS AND SCATTERED X-RAYS FROM WATER PHANTOM AT 1,000 kv

Type of X-rays	Angle of Scattered X-rays	Ratio Photographic to Ionization Intensity
Primary, unfiltered	...	1.0
Primary, filtered by phantom	...	1.3
Scattered	18°	2.1
Scattered	90°	4.3

the presence of scattered radiation of somewhat softer quality than the primary. The secondary radiations from the lateral and front surfaces of the water phantom showed the presence of a soft component, presumably consisting of secondary electrons since a 1-mm. aluminum filter over the film reduced the intensity by 10 to 15 per cent. Secondary radiation from the rear of the phantom showed almost no absorption in 1 mm. aluminum.

The 1,000-kvp resonance-type generator is designed to permit exposures with both forward and lateral beams of x-rays. If only the forward beam is to be used, the lateral direct radiation may be largely absorbed by a lead sleeve mounted over the target end of the tube. Braestrup and Wyckoff (2) found that 100 pounds of lead used in this way reduced the lateral radiation to an intensity roughly equivalent to that of the 90° scattered radiation from a phantom exposed to the forward beam.

In film monitoring of stray x-radiation arising from a 1,000-kv generator, the safe procedure is to calibrate the films with the primary x-rays or with the gamma rays of radium. Any degree of overvaluation by the films will depend on the relative proportions of direct stray radiation and softer secondary x-rays. In evaluation of the x-rays only, the secondary electrons should be removed by filters on each side of the film packet, consisting of 1 mm. of aluminum for 1,000-kv x-rays, or 0.5 mm. of copper or brass for 2,000-kv x-rays or for the gamma rays of radium. Similar filters should be over the films used for calibration exposures.

SUMMARY

The technic of the photographic measurement of radiation quantity and quality is discussed in relation to film monitoring and to experiments described in this paper.

With therapeutic x-ray installations at 200 to 250 kv, completely enclosed in a protective barrier, either the heavily filtered primary radiation or the gamma rays of radium are satisfactory choices for exposing the calibrating films. If the situation is such that the stray radiation to be measured is predominantly scattered radiation from the patient, the normally filtered primary x-ray beam is the best choice for film calibration.

With 1,000-kv x-rays, the primary radiation, either filtered or unfiltered, or the gamma rays of radium may be used for exposing the calibration films. If the arrangement is such that scatter from the patient may reach neighboring personnel, some overvaluation of this scatter may occur.

ACKNOWLEDGMENT: Our thanks are due to Mr. Wayne Larimore for his valuable assistance in a portion of this work.

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SUMARIO

Experimentos en el Registro Fotográfico de los Rayos X Extraviados. Parte I. Consideraciones Generales. La Elección de Radiaciones para Calibrar Películas en la Roentgenoterapia a 220 kv.p. y 1,000 kv.p.

Se discute aquí la técnica de la medición fotográfica de la cantidad y la calidad de la radiación en relación con la comprobación de las películas.

Con instalaciones terapéuticas de rayos X a 200 y 250 kv, absolutamente encerradas en una valla protectora, ya la radiación primaria filtrada intensamente o los rayos gamma del radio constituyen selecciones satisfactorias para exponer las películas de calibración. Si la situación es tal que la radiación extraviada por medir es esparcida predominantemente por el enfermo, el haz de rayos X primarios filtrados intensamente representa la mejor selección para la calibración de películas.

Con rayos X de 1,000 kv, cabe usar para exponer las películas de calibración la radiación primaria, ya filtrada o no, o los rayos gamma del radio. Si las condiciones son tales que el esparcimiento desde el enfermo puede llegar al personal cercano, tal vez se exagere el valor de ese esparcimiento.

Experiments in the Photographic Monitoring of Stray X-Rays

Part II. The Characteristics of the Stray Radiations, and the Choice of Film-Calibrating Radiations in Diagnostic Radiology.[1]

R. B. WILSEY, M.A., H. R. SPLETTSTOSSER, B.S., and D. H. STRANGWAYS, B.A.[2]

THE PRIMARY difficulty in the use of photographic film for evaluating exposures to stray radiations is the great variation in relative photographic and ionization effects as the photon energy or quality of the radiation is changed (6, 8, 12, 13, 17). In the principal diagnostic range of x-ray tube voltages (60 to 125 kvp), however, the film sensitivity for lightly filtered primary radiation has been found to vary but little (17); presumably, if the quality of the scattered radiation does not differ too much from that of the primary, the latter can be used satisfactorily for the calibration of the films. Another problem is that of the relative proportions of the radiation scattered from the patient and the heavily filtered direct stray radiation emerging through the x-ray tube housing, both of which may be evaluated quite differently by the film.

TESTS FOR SOFT COMPONENTS OF SECONDARY RADIATION

In the case of the human body, or a phantom, some of the emergent secondary radiation has been scattered many times, and the question arises as to whether, because of the Compton effect, this repeated scattering results in an extremely soft radiation that might fail to be evaluated correctly by either photographic or ionization monitoring. This effect would be expected to be most prominent in the radiation scattered from the phantom back toward the x-ray tube. The absorbability of such radiation was tested by mounting thin filters ("test filters") of aluminum over the window of the Seemann soft x-ray chamber (11). The x-ray tube was operated at 70 kvp, and tests were made both with and without a 1-mm. aluminum filter in the primary beam.

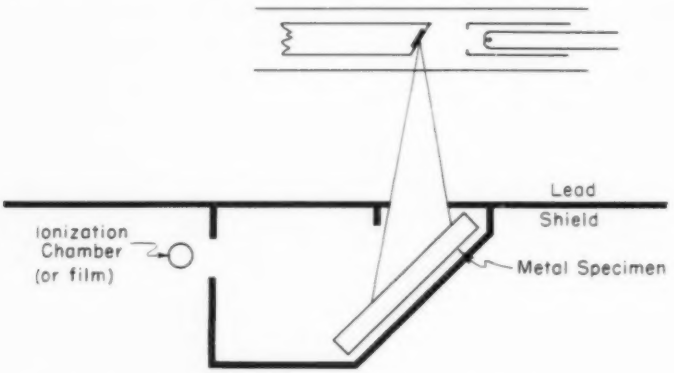

Fig. 1. Arrangement for testing the secondary radiation from metals.

As a check on the method, tests for soft components of the secondary radiations from aluminum, iron, and lead were also included. The fluorescent K-radiation of iron (excitation potential 7.1 kv) and the L-radiation of lead (excitation potential 15.8 kv) should be indicated by this test. The experimental arrangement is illustrated in Figure 1. The metal specimen

[1] Communication No. 1720 from the Research Laboratories, Eastman Kodak Co., Rochester, N. Y.
[2] Deceased.

was set at 45° to the central ray, and observations were made on the secondary radiation emitted from the surface at 90° to the central ray.

The principal data are recorded in Table I. For the unfiltered primary radiation, the "absorption indices" (common logarithms of the reciprocal of the x-ray transmission) for back-scatter from the water phantom are generally less than those of the primary radiation, showing that this secondary radiation is less absorbable, or slightly harder, than the primary. The data on secondary radiation from aluminum are somewhat mixed, but indicate no great difference from the primary radiation. The secondaries from iron and lead exhibit high absorption, showing that the soft fluorescent radiations form the dominant feature of the secondary radiations from these metals.

In similar tests, with the primary radiation filtered by 1 mm. of aluminum, the absorptions of the primary radiation and of the secondaries from water and aluminum were substantially alike, while the secondaries from iron and lead showed the high absorptions characteristic of their soft fluorescent radiations.

TABLE I: TESTS FOR SOFT COMPONENTS OF SECONDARY RADIATIONS WITH SEEMANN SOFT X-RAY CHAMBER (70 kvp. No added filtration)

Test Filter (mm. Al)	Absorption Indices (Ionization)				
	Primary Radiation	Secondary Radiation from Front Surface of			
		Water Phantom	Aluminum	Iron	Lead
0.1	0.06	0.06	0.09	0.98	0.20
0.4	0.18	0.15	0.18	1.82	0.73
1.0	0.35	0.28	0.28	..	1.40

QUALITY OF SCATTERED RADIATION

The qualities of the radiation scattered in various directions from the water phantom were tested by their absorptions by the following filters: 0.4 mm. aluminum, 1.0 mm. aluminum, and 0.25 mm. copper. The measurements are expressed in absorption indices. In the main, these were determined photographically. The filters were mounted over portions of a film (Kodak Industrial X-ray Film, Type K) enclosed in an opaque paper envelope, and the films were mounted in various positions around the phantom, as indicated in Figure 2 of the preceding paper. This sketch shows a plan view, as the experimental arrangement would appear from a point vertically above. The primary x-ray beam is directed horizontally. The angles of scatter were measured from the forward direction of the central ray. The ionization chamber, or films, were protected by shields (not shown) against the secondary radiation from the tube window and the filter and also from the walls of the room. The film densities in shadows of the secondary radiation filters and in the adjacent areas were read on a densitometer, and these values were converted into relative intensities with the aid of the appropriate sensitometric curve.

It should be pointed out that in these experiments the data were obtained only for *comparison* of the radiation qualities under test. The absolute values of the absorption indices are not very significant, since they are affected to some extent by the particular geometric arrangement and by the x-ray spectral sensitivity of the film.

The results of the photographic tests on the quality of radiation scattered in various directions from the water phantom are recorded in Table II for 70-kvp primary radiation filtered by 1 mm. of aluminum. Ionization tests of the scattered radiation were also made with the Victoreen Protexiimeter radiation meter. In this case, the secondary radiation filters were mounted in front of the meter chamber. As may be expected, the photographic and the ionization absorption indices are different, but both show the same trend in the comparison of the qualities of the various radiations. The radiations scattered at 90° and 170° (the angle range most likely to include neighboring personnel) differ only slightly from the primary radiation whereas the forward scatter is appreciably harder.

Photographic tests, similar to those described, were made on the quality of radiation scattered from patients in a room

TABLE II: QUALITY OF SCATTER FROM WATER PHANTOM
(70 kvp. 1-mm. Al added filtration)

Radiation	Angle of Scatter	Absorption Indices				
		Photographic			Ionization	
		0.4 mm. Al	1.0 mm. Al	0.25 mm. Cu	1.0 mm. Al	0.25 mm. Cu
Primary	...	0.06	0.13	0.70	0.20	0.79
Scattered	30°	0.05	0.10	0.54	0.12	0.60
Scattered	90°	0.05	0.11	0.66	0.16	0.77
Scattered	170°	0.06	0.12	0.71	0.20	0.86

TABLE III: COMPARISON OF PHOTOGRAPHIC AND IONIZATION EVALUATIONS OF SCATTERED RADIATION FROM WATER PHANTOM

Angle of Scatter	Ratio Photographic to Ionization Measurement		
	70 kvp	100 kvp	125 kvp
30°	1.06	1.00	0.96
90°	1.00	0.97	1.04
165°	0.94	0.98	1.03

devoted to general diagnostic radiography. The films were mounted on the wall and left for several days. The radiation reaching them was predominantly lateral scatter. The absorptions shown by the filters over the films were very similar to those for the principal primary radiation (70 kvp) used in this room.

In view of the fact that film sensitivity to the general radiation has little variation over the diagnostic range of voltage, it is to be expected that films will measure all these scattered radiations with reasonable accuracy. In accord with this expectation is the experience of Clark and Jones (3), who found that films calibrated by 90-kvp primary radiation correctly evaluated the stray radiation received by personnel engaged in radiologic diagnosis.

To test this point more fully, comparative film and ionization measurements were made of the intensities of radiation scattered in three directions from the water phantom when exposed to primary radiations of 70 kvp, 100 kvp, and 125 kvp, each filtered by 1 mm. of aluminum. The ratios of the photographic to the ionization values of these secondary radiations are listed in Table III. These ratios all approximate unity, indicating substantial equality of the two methods of monitoring the scattered radiation. The actual intensities of scattered and primary radiations observed in this experiment are recorded in Table IV.

Both the aluminum filter over the x-ray tube portal and the wood-paneled walls of the room contributed appreciable amounts of scattered radiation. In observations of lateral scatter from the water phantom at 1-meter distance, scatter from the 1-mm. aluminum filter added as much as 25 per cent to the measurement, and a similar increase from the walls of the room was obtained if the film or ionization chamber was not properly shielded.

INTENSITY OF SCATTERED RADIATION

Another important question is how the intensity of scattered radiation from the patient compares with that of direct stray radiation emerging from the x-ray tube through the tube housing. The film evaluations of the scattered radiation and the heavily filtered direct stray radiation will generally be quite different.

The National Bureau of Standards Handbook 41 on *Medical X-Ray Protection up to Two Million Volts*, of March 30, 1949, limits stray radiation through a diagnostic x-ray tube housing to a maximum of "0.10 r per hour (1.67 mr per minute) at a distance of 1 meter from the tube target when the tube is operating continuously at its maximum rated current for the maximum rated voltage." Typical current ratings of rotating anode tubes for continuous operation are 4 ma at 100 kvp or 3 ma at 125 kvp. Thus, the permissible direct stray radiation may be computed at

TABLE IV: INTENSITIES OF RADIATION SCATTERED FROM WATER PHANTOM AT RADIOGRAPHIC VOLTAGES. PRIMARY RADIATION FILTERED BY 1 mm. OF ALUMINUM

Kvp	Primary Radiation r/ma-min. at 30 in.	Scattered Radiation			
		30°		90°	
		mr/ma-min. at 1 meter	Per Cent	mr/ma-min. at 1 meter	Per Cent
70	0.415	0.31	0.075	0.93	0.22
100	1.00	1.28	0.128	3.0	0.30
125	1.50	2.40	0.160	5.0	0.33

0.42 mr/ma-min. at 1 meter for a 100-kvp tube and 0.56 mr/ma-min. for a 125-kvp tube.

X-ray tube housings constructed in accordance with the earlier recommendations of Handbook No. 15 of the National Bureau of Standards on *X-Ray Protection* would have a lead equivalent of 1.5 mm. for a 100-kvp tube. The lead absorption curves reported by Braestrup (1) give a transmission of 0.73 mr/ma-min. at 1 meter for 1.5 mm. of lead at 100 kvp, which is somewhat greater than that permitted by the newer recommendations. Our own measurement of the transmission of 1.5 mm. of lead for 100-kvp x-rays, giving 0.67 mr/ma-min. at 1 meter, agrees closely with Braestrup's value.

Braestrup (2) investigated the stray radiation occurring under the conditions of fluoroscopy at 80 kvp. With most field sizes, he found the scattered radiation to be many times larger than the direct stray radiation allowed by present-day standards of x-ray tube protection. With a field diameter as small as 8 cm., however, the scattered radiation was of the same order as the direct stray radiation which now may be expected at 80 kvp.

In radiography the field size is, of course, generally well in excess of the film dimensions, and at tube voltages of 80 kvp or less the direct stray radiation is negligible compared to the scatter from the patient. However, although most diagnostic examinations are done at 70 to 80 kvp or below, some radiographic studies are performed at voltages up to the limit of a 100-kvp generator, where the direct stray radiation would be a maximum for a 100-kvp tube. In the present work, comparisons were made of the scattered and direct stray radiations under typical radiographic conditions at 100 kvp.

The intensity of scattered radiation from the patient will depend on the size of the primary radiation field. Examination of the fields covered by several modern self-protected diagnostic tubes gave diameters of two-thirds to three-fourths the distance from the tube focus.

To simulate the conditions of radiography of the anteroposterior lumbar spine, a composite phantom was assembled by superimposing a hollow phantom of Presdwood, to represent the chest, on top of the water phantom. This composite phantom was backed by a panel of 1/4-inch Synthane plastic and a Potter-Bucky diaphragm to represent a radiographic table. Data were obtained for a "focus-film" distance of 48 inches, with a field of exposure 32 inches in diameter in the plane of the radiographic film. At 100 kvp, with 1 mm. aluminum filtration, the 90° scatter was 0.49 per cent of the primary radiation incident on the surface of the phantom, or 3.9 mr/ma-min. at 1 meter from the center axis of the phantom. The 170° scatter (back toward the x-ray tube) was about four times as intense as the 90° scatter.

In addition, film measurements were made of the 90° scatter from patients of medium size undergoing routine radiographic examination of the anteroposterior lumbar spine. At the 70-kvp tube voltage customarily used in these examinations, the average value of the lateral scatter was approximately 2 mr/ma-min. at 1 meter. Additional exposures at 100 kvp gave a value of approximately 5 mr/ma-min. at 1 meter. This value is somewhat higher than that observed on the composite phan-

tom, partly because of the higher output of the x-ray generator used and partly because scatter from the tube filter and from the walls of the room was included in the measurement.

At 100 kvp these values of 90° scatter are large compared to the various values of direct stray radiation reported above (0.4 to 0.7 mr/ma-min. at 1 meter), while at 70 kvp there is even greater predominance of scatter over direct stray radiation, which is estimated to be less than 0.05 mr/ma-min. at 1 meter.

It is to be recognized that primary x-ray intensity per milliampere at a specified peak voltage, as well as the corresponding intensity of scattered radiation, will vary from one x-ray generator to another, and with different tube currents in the same generator. Such effects are largely attributable to changes in voltage wave form. Ritter, Warren, and Pendergrass (10) reported a survey of fourteen radiographic machines, of five different makes, in various hospitals in Philadelphia and, for the same nominal conditions of tube voltage and current, found variations in x-ray output as large as ±20 per cent from the average. The research x-ray generator used in our measurements of scatter from phantoms, under the various operating conditions, gave outputs ranging from the average to approximately the minimum observed by Ritter, Warren, and Pendergrass. The intensities of scattered radiation found in these tests may, therefore, be considered conservative in comparison with those to be expected with the general run of radiographic machines.

At 70 kvp, film sensitivity is about the same for the lightly filtered and the heavily filtered radiation, and at 80 kvp the difference in the two sensitivities is not great (17), so that at 80 kvp, or below, no serious error is involved in evaluating the *direct portion* of the stray radiation by films calibrated by the useful primary radiation.

With the 125-kvp tube, the permissible direct stray radiation is the same as for the 100-kvp tube, but because of a lesser continuous tube current rating, the value is slightly greater as expressed in mr/ma-min. at 1 meter. In the same terms, scatter from the patient increases in even greater proportion, so that at 125 kvp the preponderance of scattered radiation over direct stray radiation is more than maintained.

In connection with the tests on both the composite phantom and live subjects, observations were taken of the lateral scatter from the radiographic table itself (with plastic panel top), with the Potter-Bucky diaphragm shifted away from the radiographic field. The 90° scatter was about 40 per cent of that with a patient or phantom in place. With the full field of the radiographic tube, this represents the minimum scatter occurring in the radiography of small parts. This means that at 100 kvp the table-top scatter would be about four times the intensity of the direct stray radiation now permissible. If the primary beam were diaphragmed to a small size, however, the preponderance of scatter over direct stray radiation would no longer exist, but since small parts are ordinarily radiographed at voltages well below 80 kvp, the low intensity of scatter would pose no special problem in the choice of film-calibrating radiation.

With the full aperture of the x-ray tube, variation of focal distance would have little or no effect upon the intensity of table-top scatter, since the change in area exposed would largely compensate for the change in primary x-ray intensity. In an installation used for general radiography it is common practice, for the sake of convenience, to employ the full tube aperture in the examination of practically all parts of the body. In a department where the volume of work is large, some x-ray rooms may be restricted to the radiography of a single body part, and in this case it may be feasible to diaphragm the primary beam to a size just sufficient to cover the film or the area of diagnostic interest, thereby lessening the intensity of scattered stray radiation. If most of the exposures are made at voltages near 70 kvp or below, it is not essential that direct stray radiation be

small compared to the scattered radiation. However, if most of the exposures are made at voltages near the upper limit of the x-ray tube, and if it appears doubtful that the direct stray radiation can be ignored in comparison with the scattered radiation, the monitoring films should be calibrated with heavily filtered primary radiation. For this purpose, 100-kvp x-rays may be filtered with as much as 4 mm. of copper, and 125-kvp x-rays with 5 mm. of copper. It is difficult to state a precise rule for estimating the reduction of stray scattered radiation by diaphragming the primary x-ray beam, but, roughly speaking, for a given focus-film distance this reduction can be taken as proportional to the decrease in the area of the radiographic field.

Many radiographic installations are devoted largely, or entirely, to radiography of the chest. With a focus-film distance of 6 feet, stray scattered radiation can be reduced materially by diaphragming the primary x-ray beam to a size sufficient to cover the film, with sufficient leeway to allow for the stereoscopic tube shift and for errors in centering the tube. In this case the stray scattered radiation, in terms of mr/ma-min. at 1 meter, may not greatly exceed the direct stray radiation at voltages near the upper limit for the x-ray tube. In the main, such high voltages are used only in chest radiography with the Potter-Bucky diaphragm. Since most chest radiographs, especially of patients of medium and small sizes, are made without the Potter-Bucky diaphragm, at voltages below 80 kvp, it appears safe, in such an installation, to calibrate the monitoring films with the normal primary radiation.

In general radiography up to 100 kvp, the selection of tube voltage for exposing the calibration films is not critical. Probably the best choice would be the voltage most commonly used in the diagnostic examinations. With the 125- or 130-kvp generator, the maximum tube voltage is to be preferred for exposing calibration films.

Surveys of stray radiation in radiological departments have been reported by a number of observers, including Braestrup (2), Jacobson, Schwartzman, and Heiser (9), and Geist, Glasser, and Hughes (7). In some instances, these surveys disclosed unexpected sources or leaks of stray radiation, particularly in fluoroscopy and in various special procedures. Wherever proper safety precautions were followed, stray radiation received by personnel was but a small fraction of the maximum permissible dose of 0.3 r per week. A common instance of excessive exposure occurred when a technician held a patient during the x-ray examination. This difficulty was eliminated by the substitution of a mechanical support of the patient or by restricting this duty to personnel not otherwise engaged in radiological work. Full-time dental x-ray technicians, who depended entirely on distance for protection, were also subject to fairly high exposures.

The principal factor in assuring the safety of the technician is a protective barrier shielding him from the patient and the x-ray tube. There is some further advantage in shielding him from most, or all, of the wall and ceiling surfaces of the x-ray room. Van Allen (14) has reported data on the distribution of stray radiation around various photofluorographic installations, including measurements of the small amount scattered from walls and/or the surrounding atmosphere into the area behind the protective shield.

Even though the operator at the control stand is in a well protected position, an assisting technician may fail to seek cover during exposure of the patient. Monitoring of x-ray personnel serves to check any laxity in observance of safety precautions. It would seem to be especially important in fluoroscopy and in the various special examinations where close proximity to the patient is necessary, and where protection is a complex problem requiring careful placement of protective materials and particular attention to safe manipulative procedure.

FLUOROSCOPY

In fluoroscopy, diaphragming the primary x-ray beam reduces the intensity of

TABLE V: QUALITY TESTS AND PHOTOGRAPHIC EVALUATIONS OF RADIATION SCATTERED FROM WATER PHANTOM

(80 kvp. 2 mm. Al filtration added. 16 in. focus-skin distance)

Angle of Scatter	"Screen" Field Size (cm.)	Ionization Absorption Indices 1.0 mm. Al	Ionization Absorption Indices 0.25 mm. Cu	Ratio of Photographic to Ionization Measurement
30°	8 × 8			0.94
	16 × 16	0.06	0.38	0.99
	32 × 32	0.07	0.41	0.94
90°	8 × 8			1.00
	16 × 16	0.08	0.49	1.00
	32 × 32	0.09	0.51	0.96
	Whole phantom	0.10	0.56	

Since, as demonstrated by radiographic tests, water has a somewhat higher absorption for x-rays than average abdominal tissue has, the forward scatter from the phantom will be harder than that from a human abdomen of equal thickness. The fact that this scatter is measured by the film at substantially full value (Tables III and V) shows that, under diagnostic conditions, all scattered radiation lies within the range of qualities which are suitably evaluated by the film.

The intensities of the scattered radiation at the various field sizes are recorded in Table VI. For comparison, the permissible direct stray radiation intensities at 80 and 100 kvp are given for a 100-kvp tube. The intensity at 100 kvp is that specified in National Bureau of Standards Handbook 41. According to Braestrup's (1) x-ray absorption curves in lead, this intensity of direct stray radiation (0.42 mr/ma-min. at 1 meter) would require a protective equivalent of 1.7 mm. of lead. By interpolation from these curves, this thickness is found to transmit about 0.06 mr/ma-min. at 1 meter at 80 kvp.

TABLE VI: INTENSITY COMPARISON OF 90° SCATTER FROM WATER PHANTOM, DIRECT STRAY RADIATION, AND INCIDENT PRIMARY RADIATION UNDER CONDITIONS OF FLUOROSCOPY

("Focus-skin" distance 16 in.)

Type of Radiation	"Screen" Field Size (cm.)	Radiation Intensity: 80 kvp, 2 mm. of Al — mr/ma-min. at 1 Meter	80 kvp, 2 mm. of Al — Per Cent	100 kvp, 2 mm. of Al — mr/ma-min. at 1 Meter	100 kvp, 2 mm. of Al — Per Cent
Direct (a)*	...	0.06±	0.004±	0.42	0.019
stray (b)*	...	0.09±	0.006±	0.7	0.031
Scattered	8 × 8	0.04	0.0023	0.08	0.0037
Scattered	16 × 16	0.26	0.016	0.51	0.023
Scattered	32 × 32	1.36	0.083	2.44	0.11
Primary	...	1.64 r/ma-min. at 16 in.	100	2.26 r/ma-min. at 16 in.	100

* Direct stray radiation estimated in accordance with (a) National Bureau of Standards Handbook 41, March 30, 1949, and (b) National Bureau of Standards Handbook 15, May 16, 1931.

At 80 kvp, the direct stray radiation is small compared to the scattered radiation at most field sizes. Considering the small difference in film sensitivity between lightly and heavily filtered 80-kvp x-rays, it is apparent that the lightly filtered 80-kvp primary radiation may safely be used for calibration of the monitoring films.

At 100 kvp the situation is not so favor-

stray scattered radiation and raises the question of whether the *quality* of the scattered radiation is also changed sufficiently to affect its evaluation by monitoring films. To simulate the conditions of fluoroscopy, the phantom was set at a "focus-skin" distance of 16 inches, and filtration tests with an ionization chamber were made of the quality of the scattered rays with various field sizes. Ratios of photographic to ionization evaluation of the radiations were also determined. The data for 80-kvp primary x-rays, filtered by 2 mm. of aluminum, are listed in Table V. These data show that diaphragming the primary beam hardens the scattered radiation slightly, but not enough to affect the validity of its film evaluation. The same conclusions were afforded by similar tests made with 100-kvp x-rays filtered by 3 mm. of aluminum.

able; if much of the fluoroscopy is done at the smaller field sizes, it would be safer to calibrate the films by heavily filtered primary x-rays to avoid undervaluation of the stray radiation.

SECONDARY RADIATION FROM WALL MATERIALS

At several stages of this investigation, the relative intensities of the secondary radiation from various materials were measured under a variety of conditions as to x-ray tube voltage and relative positions of x-ray tube, specimen, and measuring device. A systematic study of all the factors involved was not attempted but, in assessing the data obtained, certain general conclusions could be derived. In accordance with general experience, the lighter materials, such as water, wood, and light plastics, usually emitted secondary radiation of the highest intensity. That from aluminum was definitely lower. The secondary radiations from iron and lead were found to vary greatly, depending largely on the spectral sensitivity of the measuring device.

These findings suggest two useful possibilities. One is that, in the construction of a diagnostic x-ray room, wall materials might be selected that would minimize the stray radiation from this source, which may reach working personnel even though they are shielded from radiation emerging from the patient and the x-ray tube. Another possibility is that in experimental work x-ray-measuring instruments can be more effectively protected from stray radiation by a suitable choice of shielding materials.

Since the secondary radiations from iron and lead are chiefly soft fluorescent rays, the evaluation of their secondaries depends largely on the sensitivity of the measuring device to these very soft components. The limitations of thimble-type chambers in the measurement of such soft x-rays have been pointed out by Victoreen, Atlee, and Trout (15) and by Day (4, 5), while the low film sensitivity for x-ray energies below 25 kev would indicate that film is similarly handicapped. In the present study, evaluations of the fluorescent radiations from iron and lead were made by photographic film and by the Victoreen pocket and Proteximeter radiation meters, in comparison with the Seemann soft x-ray chamber (11), with results as recorded in Table VII. All three of these devices showed serious undervaluation of the iron radiation, but only the film gave marked undervaluation of the lead radiation.

TABLE VII: COMPARISON OF PHOTOGRAPHIC AND IONIZATION EVALUATIONS OF SECONDARY RADIATIONS FROM IRON AND LEAD AT 70 KVP, WITH NO ADDED FILTRATION

Metal	Ratio Photographic to Ionization Measurement (Soft X-ray Chamber)	Ratio Pocket Chamber to Soft X-ray Chamber	Ratio Proteximeter to Soft X-ray Chamber
Iron	0.23	0.36	0.26
Lead	0.37	0.84	0.84

As measured by the Seemann chamber, the intensities of the secondary radiations from iron and lead were found to be quite high, comparable to or exceeding those of the light materials. As shown in Table VII, the thick-walled chambers record a relatively high value for the lead secondary, but a low value for the iron secondary. In other tests both the photographic film and an ionization chamber, when covered with a 1-mm. aluminum filter, ascribed low intensities to the secondaries from both iron and lead, that from iron being the lowest for any of the materials tested.

By covering iron and steel with thin layers of aluminum, their soft secondary radiations can be largely suppressed, while the aluminum adds somewhat to the harder scattered component, the quality of which is comparable to that of the incident primary x-ray beam. Tests were made with both iron and lead to determine for each the thickness of aluminum covering which would produce the minimum total intensity of secondary radiation, as measured by the Seemann soft x-ray chamber. The exposures were made at 70 kvp with a 1-mm. aluminum filter over the x-ray tube aperture. The specimen was set at an angle

TABLE VIII: OPTIMUM THICKNESS OF ALUMINUM OVER STEEL AND LEAD TO REDUCE SECONDARY RADIATION TO A MINIMUM

mm. Aluminum Over Material	r/min. (Seemann Chamber) Steel	Lead
0	0.78	0.78
0.25	0.078	0.27
0.50	0.094	0.152
0.75	0.106	0.134
1	0.122	0.137
2	...	0.157

of 45° to the central ray, and the secondary radiation was measured in a direction perpendicular to the specimen. The resulting data are recorded in Table VIII. From these data, the optimum aluminum thickness is taken as 0.25 mm. for steel and 0.75 to 1 mm. for lead.

Measurements under the same conditions were made of the relative intensities of the secondary radiation from several typical wall materials, as well as from aluminum, steel covered with 0.25 mm. of aluminum, and lead covered with 1 mm. of aluminum. Film measurements of these secondaries were also made and, with both film and the Seemann chamber, absorption indices of the radiations were determined for a 1-mm. aluminum filter mounted over the measuring device. Preliminary tests had shown that the secondary radiations from concrete, and from Sheetrock board[3] over concrete, cinder block, or hollow tile, were similar in intensity. Therefore, only the Sheetrock board over concrete was included in the further tests. In the preliminary tests also, 1/2-inch plywood was found insufficient to suppress fully the soft secondary radiation from its lead backing, so that in the new tests plywood thicknesses of 3/4 inch and 1 inch were added. All the specimens (except the aluminum-covered lead) were backed by 1/16 inch of lead. The resulting data are recorded in Table IX.

For the 1/2-inch plywood, both the high absorption index and the low film evaluation indicate the influence of the soft fluorescent radiation from the lead backing. In practice, however, the use of a plywood thickness as low as 1/2 inch should not result in serious undervaluation by film measurement, since in directions other than the perpendicular, the effective path through the plywood is greater than 1/2 inch. Film measurements of the secondary radiation emitted at angles of 45° or more from 1/2-inch plywood (backed by lead) showed satisfactory agreement with the ionization measurements. The film measurements of the secondary radiation from the other materials of Table IX show no significant undervaluation.

TABLE IX: SECONDARY RADIATION FROM STRUCTURAL MATERIALS

Specimen	r/min. Seemann Chamber	Absorption Index for 1 mm. of Al		Ratio of Film to Ionization Intensity
		Seemann Chamber	Film	
1/2-in. plywood	0.46	0.28	0.19	0.84
3/4-in. plywood	0.49	0.22	0.16	0.92
1-in. plywood	0.61	0.18	0.15	0.96
1/2-in. Sheetrock board	0.176	0.19	0.13	0.98
1/2-in. Sheetrock board over concrete	0.208	0.15	0.12	1.02
1/2-in. aluminum	0.216	0.16	0.11	1.02
1/2-in. steel + 0.25 mm. Al	0.073	0.19	0.14	0.94
3/16-in. lead + 1 mm. Al	0.134	0.20	0.16	0.97

A masonry material, such as concrete, or plaster over lead, concrete, cinder block, or hollow tile, emits less than half as much secondary radiation as 1/2-inch plywood.

If it were possible to obtain a wall covering of steel overlaid with 0.25 mm. of aluminum, it would emit the lowest intensity of secondary radiation as measured by air ionization, and, judging from Walstam's data (16) on secondary radiation as a function of atomic number, no other material or combination would emit a lower intensity.

In making observations with x-ray-sensitive devices, it is often necessary to shield them from extraneous radiation. Under some circumstances, a wall or other

[3] A wallboard similar to plaster. United States Gypsum Co.

surface may emit secondary radiation toward the measuring device, but this may be minimized by covering the surface with sheet iron or steel. If the measuring device can be affected appreciably by the iron K-radiation, as is the case with film and the customary forms of ionization chamber, the iron or steel should be covered with a layer of 0.25-mm. aluminum. If the measuring device is not affected by the iron K-radiation, the aluminum covering of the steel should be omitted, since it merely adds its own scatter to that from the steel. For example, covering the film or ionization chamber with 1 mm. of aluminum reduces the response to the iron K-radiation to negligible proportions.

As tube voltage is increased, the K-radiation of iron forms a diminishing fraction of the iron secondary radiation. Our data indicate, however, that the advantages of the procedure described for minimizing secondary radiation apply for voltages as high as 220 kvp or higher.

SUMMARY

Filtration tests of the radiation scattered from an oval-shaped water phantom, exposed at 70 kvp, showed that the lateral scatter and the backward scatter differed little in quality from the primary radiation, while the forward scatter was somewhat harder than the primary x-rays. Films calibrated by the primary radiation were found to evaluate satisfactorily the radiation scattered in all three directions, at voltages of 70 kvp, 100 kvp, and 125 kvp.

Diaphragming the primary x-rays, as in fluoroscopy, restricted the beam to thicker portions of the phantom and hardened the radiation scattered in both the forward and lateral directions. All these radiations, however, were satisfactorily evaluated by films calibrated by the primary radiation, with exposures at both 80 kvp and 100 kvp. It is concluded, therefore, that all the scattered radiation occurring in x-ray diagnostic procedures is adequately evaluated by films calibrated by the primary radiation.

Under most practical conditions, the intensity of the direct stray radiation is small compared to that of the scattered radiation and can be ignored in choosing the calibrating radiation, but if the primary x-ray beam is sufficiently diaphragmed at voltages above 80 kvp, the intensity of the scattered radiation may not greatly exceed that of the direct stray radiation. Under these circumstances, the monitoring films should be calibrated by the heavily filtered primary radiation.

Normally, for a 100-kvp generator, the best choice of voltage for film calibration would be that most commonly used in the x-ray examinations. With the 125-kvp generator, film calibration at 125 kvp would give the highest evaluation of the stray radiation and is to be preferred.

The walls of the x-ray room contribute an appreciable portion of the stray radiation. Plaster or masonry walls scatter less than half as much as wood or other light material. In terms of ionization measurement, iron or steel covered with 0.25 mm. of aluminum emits the least intensity of secondary radiation.

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SUMARIO

Experimentos en el Registro Fotográfico de los Rayos X Dispersos. Parte II. Las Características de las Radiaciones Extraviadas y la Elección de Radiaciones para Calibrar las Películass en la Radiología Diagnóstica

Las filtraciones experimentales de la radiación esparcida de un fantasma oval de agua, expuesto a 70 kv.p., revelaron que el esparcimiento lateral y el retrógrado poco discrepaban en calidad de la radiación primaria en tanto que el delantero era algo más duro que los rayos X primarios. Las películas calibradas por la radiación primaria mostraron que valuaban satisfactoriamente la radiación esparcida en las tres direcciones, a voltajes de 70 kv.p., 100 kv.p. y 125 kv.p.

El diafragmamiento de los rayos X primarios, como en la roentgenoscopia, limitó el haz a las porciones más espesas del fantasma y endureció la radiación esparcida tanto delantera como lateralmente. No obstante, todas esas radiaciones fueron justipreciadas satisfactoriamente por películas calibradas por la radiación primaria, con exposiciones tanto a 80 kv.p. como a 100 kv.p. Dedúcese, por lo tanto, que toda la radiación esparcida en los procedimientos roentgenológicos de diagnóstico es justipreciada adecuadamente por películas calibradas por la radiación primaria.

En la mayoría de las condiciones encontradas en la práctica, la intensidad de la radiación extraviada directa es poca, comparada con la de la radiación esparcida y puede desatenderse al escoger la radiación de calibración, pero, si el haz de rayos X primarios es diafragmizado suficientemente a voltajes superiores a 80 kv.p., la intensidad de la radiación esparcida quizás no exceda considerablemente la de la radiación extraviada directa. En esas circunstancias, las películas comprobadoras deben ser calibradas por la filtración primaria filtrada intensamente.

Normalmente, para un generador de 100 kv.p., la mejor selección de voltaje para calibración de películas sería la usada más comúnmente en los exámenes con rayos X. Con el generador de 125 kv.p., la calibración de películas a 125 kv.p. daría la valuación más alta de la radiación extraviada y debe preferirse.

Las paredes de la sala de rayos X contribuyen una porción apreciable de la radiación extraviada. Las paredes de yeso o mampostería esparcen menos de la mitad que las de madera u otra substancia liviana. El hierro o acero recubierto de 0.25 mm. de aluminio emiten la intensidad mínima de radiación secundaria.

Radiation Dose Distribution in Water for 22.5-Mev-Peak Roentgen Rays[1]

G. SHAPIRO, M.S.,[2] W. S. ERNST, M.A.,[3] and J. OVADIA, Ph.D.[4]

THIS PAPER describes an investigation of the distribution of dose produced in water by 22.5-Mev-peak x-rays. Central-axis depth doses and several representative isodose distributions for a fixed-position betatron have previously been published (1, 2). The Memorial Center betatron, however, which was used in this study, differs from others previously constructed in its shielding, compensation, collimation, and suspension system. It was designed to be flexible in position so as to permit rapid, accurate alignment of an x-ray or electron beam for therapy. Because it is the model for a number of units now being installed for therapeutic purposes, a detailed study of the collimation system and compensating x-ray filter was made to determine their effect upon dose distribution in water.

INSTRUMENTATION

The data were obtained with an isodose recorder (3) which automatically analyzes and plots the relative space distribution of dosage produced by a radiation beam in air or water. This automatic isodose plotter (Fig. 1) consists of four units: a dual channel D.C. amplifier, a self-balancing ratio unit, a servo-mechanism for controlling the position of a probe detector in a water phantom, and a recorder for plotting the position of the probe detector.

The equipment used in the room with the betatron is illustrated in Figure 2. The wax-covered ionization chamber has a cylindrical air cavity 5 mm. in diameter and 5 mm. in length. This chamber is rigidly mounted on a preamplifier containing a Victoreen VX-5800 electrometer tube and a 1×10^{12} ohm input resistor. These two units are coated with wax so that they may be immersed in the water phantom. The entire detector assembly is attached to a carriage which can be moved along three perpendicular axes by means of a system of Selsyn motors. Figure 2 shows the equipment arranged for irradiation of the water phantom from above. This permits measurement of the radiation distribution from the surface of the water to a depth of 20 cm. Measurements can also be made at greater depths if irradiation is done through the 5-mm. Lucite window on the side of the water phantom.

A schematic diagram of the complete isodose recorder system is given in Figure 3. With this system, a direct measurement of the signal from the probe can be made. In order to obtain the space distribution of air cavity ionization in water, fluctuations of the incident x-ray intensity must be balanced out. This is accomplished by the use of a fixed reference chamber. The ratio of the amplified outputs of the probe and reference chamber is independent of variation in the x-ray intensity and can be read directly on the register of the "ratio unit."

This equipment can also be used for automatic plotting of isodoses. A specific isodose can be considered the locus of points in a plane where the above-mentioned ratio has a predetermined value. The difference between the predetermined ratio and the measured ratio at a specific probe position appears as a positive or negative error signal in the Brown amplifier. This signal is fed back through a servo-mechanism to the probe detector, causing it to move toward or away from

[1] From the Department of Physics and Biophysics, Sloan-Kettering Institute, New York City. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954. This work was supported in part by a grant (DR-226) from the Damon Runyon Fund and the Kress Fund.

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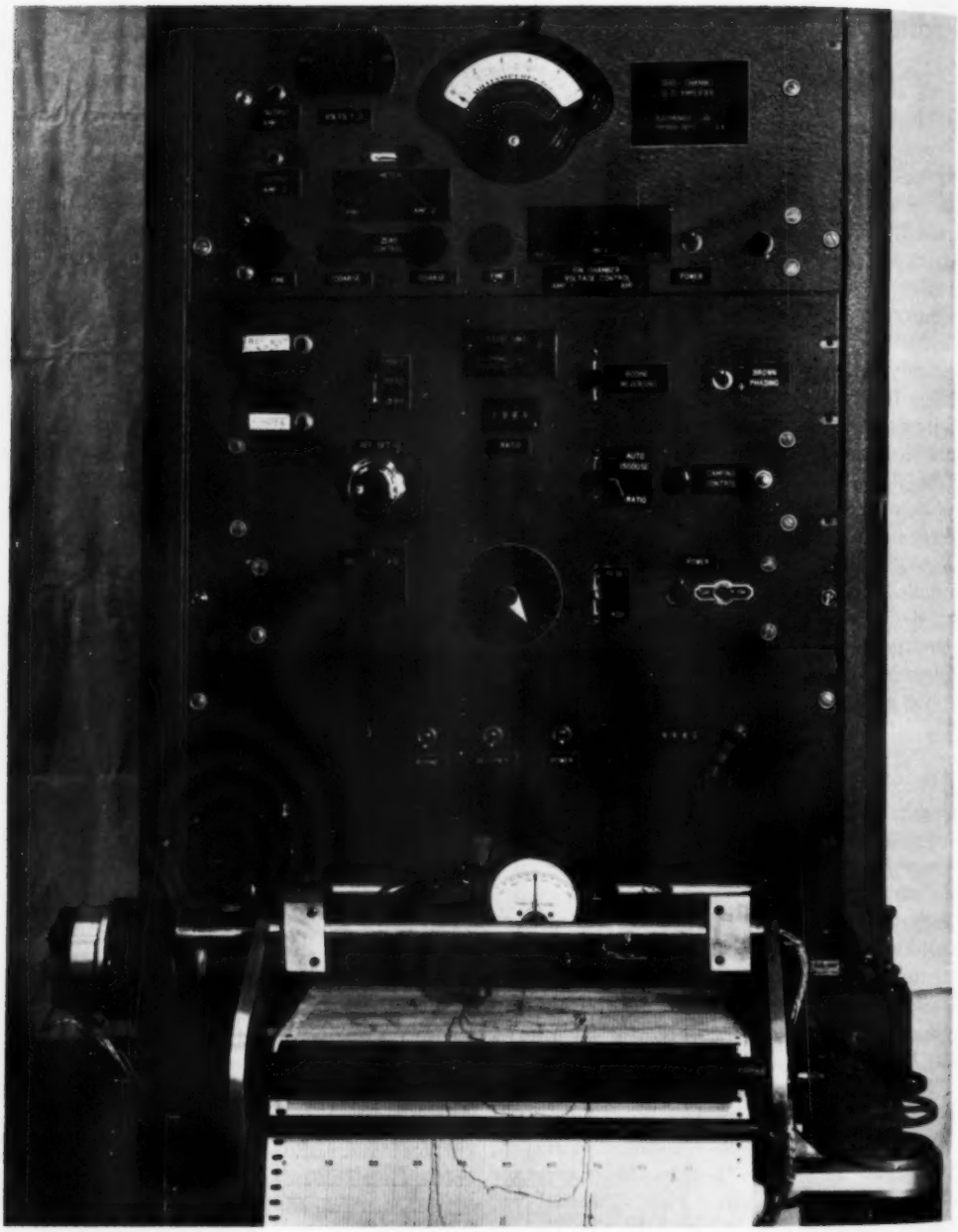


Fig. 1. Automatic isodose recorder. Top to bottom: Duo-channel D.C. amplifier, ratio unit, Selsyn control system, and automatic recording unit.

the x-ray source in order to eliminate the error signal.

The complete isodose contour is followed by moving the probe either manually or with a synchronous motor in a direction perpendicular to the beam. A pen, coupled to the probe through the Selsyn control system, traces the isodose curve

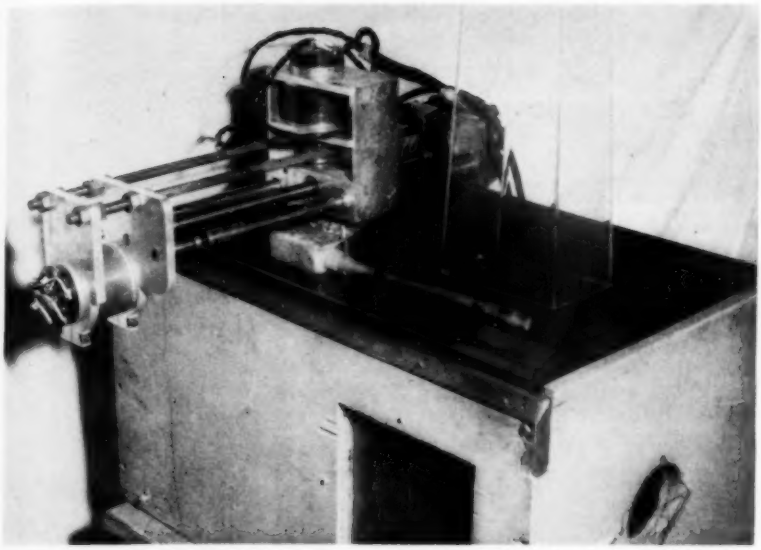


Fig. 2. Water phantom, probe detector with pre-amplifier, Selsyn motors, and three-dimensional drive mechanism. Rectangular plastic treatment cone indicates the boundaries of the vertical x-ray beam.

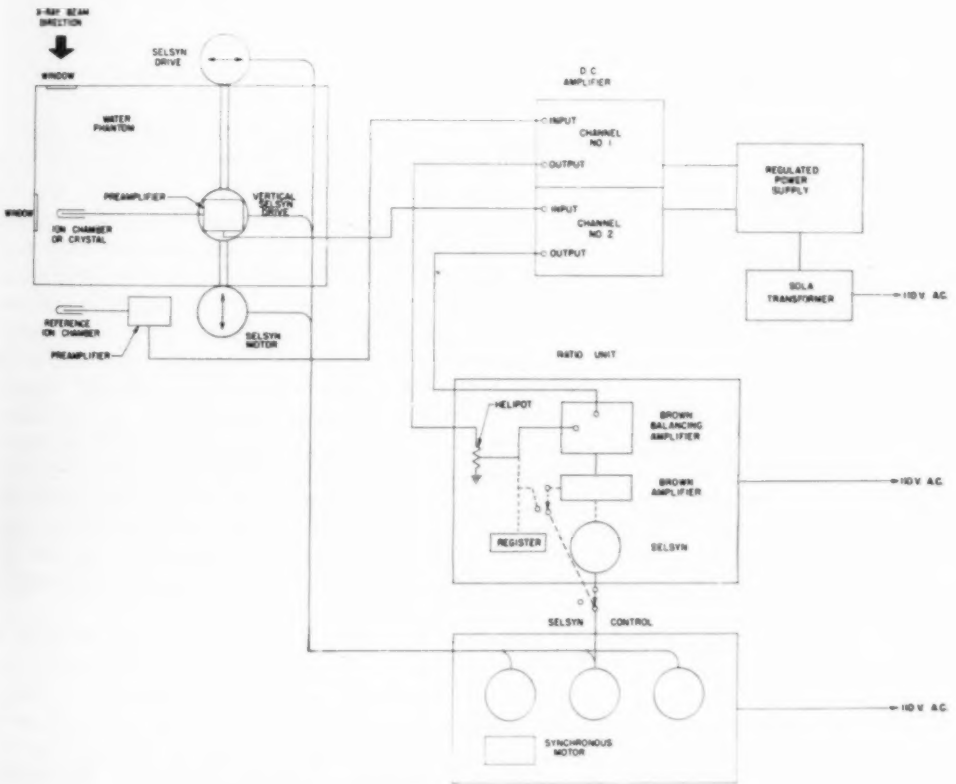


Fig. 3. Schematic diagram of isodose recorder system.

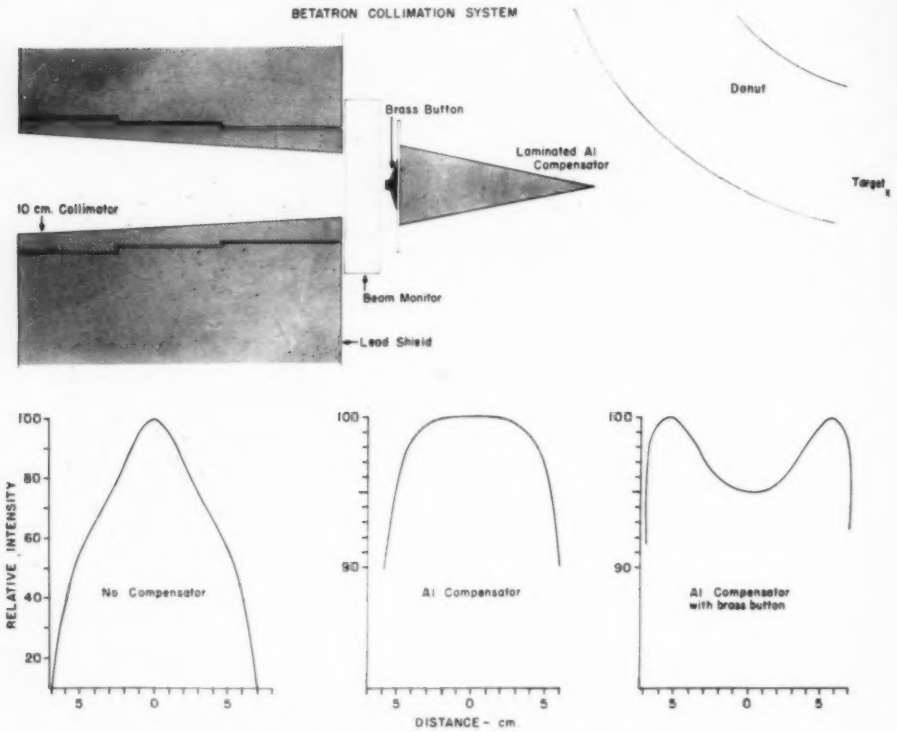


Fig. 4. Collimation and compensation system of betatron. Dose distribution in water at 4 cm. depth and 80 cm. target-surface distance with 10 × 10 cm. field.

simultaneously. Manual control of a third pair of Selsyns permits motion of the probe detector perpendicular to the plane under investigation so that a complete isodose surface can be constructed.

BETATRON COLLIMATION AND COMPENSATION SYSTEM

The unfiltered x-ray beam from a betatron is sharply peaked in the forward direction and falls off to half intensity at a half angle of 4° for 22.5-Mev-peak x-rays. For most therapeutic treatments, a flat field is desired; this is accomplished by means of a differential compensating filter. Johns *et al.* (1) used a single copper filter; Laughlin *et al.* (2) employed a series of conical ensembles of carbon or fiber and aluminum compensators, using three different filters for the various field sizes so as to maintain maximum intensity. In designing the present betatron compensator, it was decided that for practical purposes a single permanently fixed filter would be desirable, with a series of standard field sizes easily obtained by insertion of various collimators in a fixed master jacket. In the schematic drawing of the collimation and compensation system (Fig. 4), the position of the ionization chamber which monitors the beam can be seen. This unit integrates the total x-ray dose during treatment of the patient and is also used as the monitor chamber feeding into channel Number 1 of the D.C. amplifier when the isodose recorder is employed (Fig. 3).

In calculation of the optimum shape of the compensating filter, the original design was based upon having a uniform intensity at 4 cm. depth in water for a 10 × 10-cm. field at 80 cm. target-surface distance. However, with this distribution (Fig. 4), which is obtained with the alu-

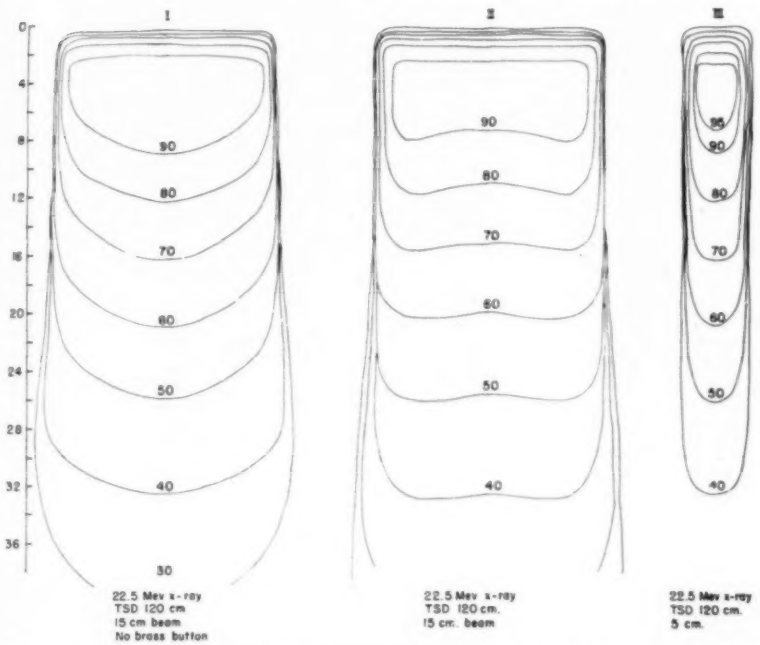


Fig. 5. Isodose distributions with Al compensator only (I) and with added brass button (II and III).

minum filter shown, it is found that for large fields (15 × 15 cm. at 120 cm. T.S.D.) there is a definite peaking of the isodose curves (Fig. 5, I).

To correct for this, a number of isodoses for different field sizes were taken with varying degrees of over-compensation. The optimum field shape (Fig. 4) was thus determined empirically and a brass button to give this distribution was then permanently attached to the aluminum compensating filter. Two representative systems of isodose distributions obtained with this final collimation and compensation system are shown in Figure 5, II and III, and all final data were taken with this arrangement.

RESULTS OF CENTRAL-AXIS DEPTH DOSE MEASUREMENTS

Prior to investigation of the complete radiation dose distributions in water, central-axis depth dose measurements were obtained for fields ranging in area from 7 to 225 sq. cm. and at target-surface

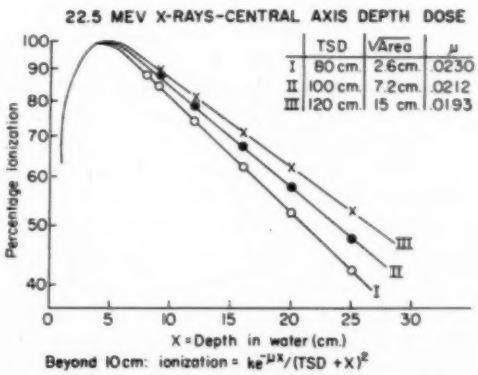


Fig. 6. Central-axis depth dose curves for various field sizes and target distances.

distances of 80 cm., 100 cm., and 120 cm. Three typical central axis depth dose curves are reproduced in Figure 6. Johns *et al.* (1) found that with their field sizes (4 to 10 cm. in diameter at 70 cm. T.S.D.), the central-axis depth dose was independent of the area of the field. Later, Laughlin *et al.* (2) found a small dependence on field size for fields less than

TABLE I

Depth in Water cm.	Percentage Depth Dose for 10 × 10-cm. Field at 80 cm. T.S.D. University of Saskatchewan* (Johns *et al.*)	University of Illinois (Laughlin *et al.*)	Memorial Center
0.5	50.5	49.0	45.0
1	70.4	72.5	67.0
2	92.3	90.0	89.0
3	98.9	96.5	98.0
4	100	100	100.0
5	98.7	98.0	98.6
6	94.2	95.5	94.4
7	89.5	92.0	92.5
8	85.8	88.5	87.2
9	83.3	85.0	83.6
10	78.5	81.5	80.0
11	75.0	78.5	76.8
12	71.5	75.0	73.8
13	68.0	72.0	70.9
14	65.1	69.0	68.0
15	62.2	66.5	65.4
16	59.5	63.5	62.9
17	57.0	61.0	60.3
18	53.9	58.5	58.0
19	51.2	56.0	55.8
20	49.4	54.0	53.7

* Data corrected from published values at 70 cm. T.S.D. to that at 80 cm. T.S.D. by assuming inverse-square attenuation.

10 cm. in diameter at 80 cm. target-surface distance but noted that for field sizes greater than 10 cm. in diameter one universal curve could be used. Table I compares these results with those obtained at Memorial Center for a 10 × 10-cm. field at a target-skin distance of 80 cm.

A study of the position of maximum ionization indicates a shift from 3.4 cm. for a 7-sq. cm. beam at 80 cm. target-skin distance to 4.8 cm. for a 225-sq. cm. beam at 120 cm. In addition, a small but regular change in the central-axis depth dose with field size is found. A previous investigation (4) showed that, within the range of irradiation distances used, the x-ray beam followed an inverse-square attenuation law. Therefore, in an attempt to correlate the change in depth dose and point of maximum ionization with irradiation area, all data were replotted with the inverse-square attenuation removed; the resultant curve resolves as a difference between two exponentials with the form:

$$e^{-\mu x} - e^{-\mu_s x}$$

where x is the depth in water, μ is an "effective absorption coefficient," and μ_s is the "build-up" coefficient.

For distances greater than 10 cm., the effect of the second term of the above expression is negligible and the central-axis depth dose in water (corrected for inverse square) follows an exponential decay with an "effective absorption coefficient," μ, which is found to vary with the area of the incident beam. A plot of μ versus $\sqrt{\text{area}}$ is shown in Figure 7, and the expression

$$\mu = 0.0236 - 0.00028 \sqrt{\text{area}} \text{ cm.}^{-1}$$

describes it within the range of areas considered and irrespective of the target distance.

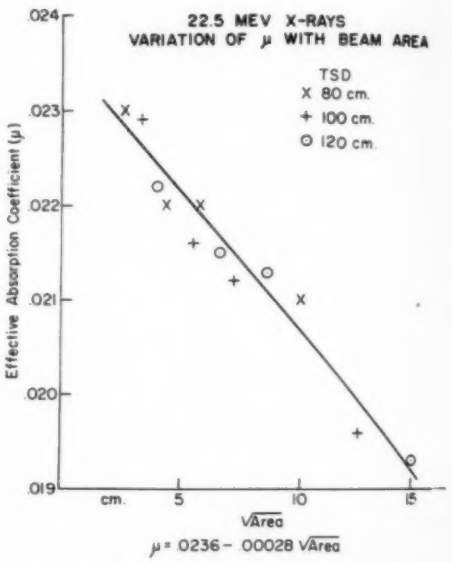
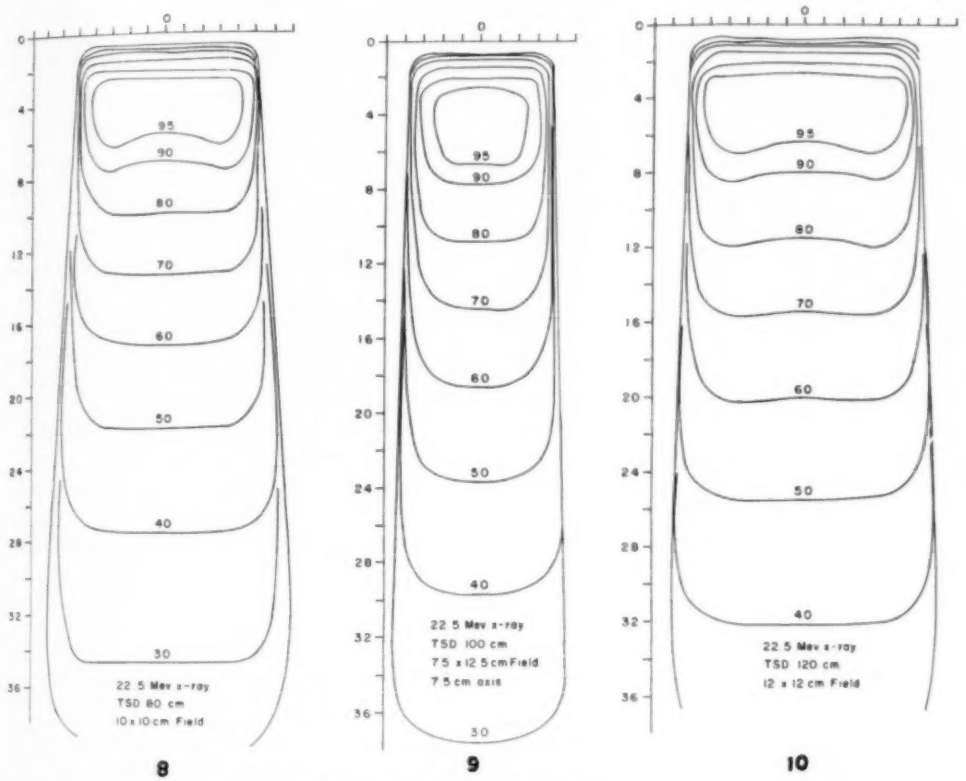


Fig. 7. Variation of the effective absorption coefficient, μ, with beam area.

The initial rise and the position of maximum ionization of the depth dose curve are chiefly determined by the "build-up" coefficient μ_s. For all field sizes between 20 and 225 sq. cm. the value of μ_s is 0.76; for field sizes between 20 and 160 sq. cm. a peak in the curve occurs at 4.0 ± 0.2 cm. The central-axis depth dose curve can then be expressed analytically by the formula:



8 9 10

Fig. 8. Isodose distribution for 10 × 10 cm. field at 80 cm. target-surface distance.
Fig. 9. Isodose distribution for 7.5 × 12.5 cm. field at 100 cm. target-surface distance, taken along 7.5 cm. axis.
Fig. 10. Isodose distribution for 12 × 12 cm. field at 120 cm. target-surface distance.

$$\text{Per cent depth dose} = \frac{100\ (\text{T.S.D.} + 4.0)^2\ (e^{-\mu x} - e^{-0.76x})}{(\text{T.S.D.} + x)^2\ (e^{-4\mu} - e^{-3.0})}$$

Investigation of one smaller field size (7 sq. cm. at 80 cm. T.S.D.) showed a point of maximum ionization at $x = 3.4$ cm. with a corresponding value of μ_s equal to 0.90. This change in μ_s for small fields is due to an increased contribution of scattered gamma rays from the sides of the collimator.

ISODOSE DISTRIBUTIONS

Isodose distributions in water for incident fields ranging from 7 to 100 sq. cm. at 80 cm. T.S.D., 35 to 155 sq. cm. at 100 cm. T.S.D., and 54 to 225 sq. cm. at 120 cm. T.S.D. have been measured with the x-ray beam normal to the surface of the phantom and at angles of incidence of 30° and 60°. The betatron was operated at 22.5 Mev, with energy calibrations obtained by independent measurements of the magnetic field and threshold activation measurements of copper, tantalum, and carbon. The field was compensated as discussed above and as shown in Figure 5. The isodose distributions obtained with the beam directed horizontally or vertically were the same. Representative isodose curves are shown in Figures 8 to 11.

SUMMARY

An automatic isodose recorder was used for the determination of isodose contours produced by a radiation beam in water. The design of a collimator and of a com-

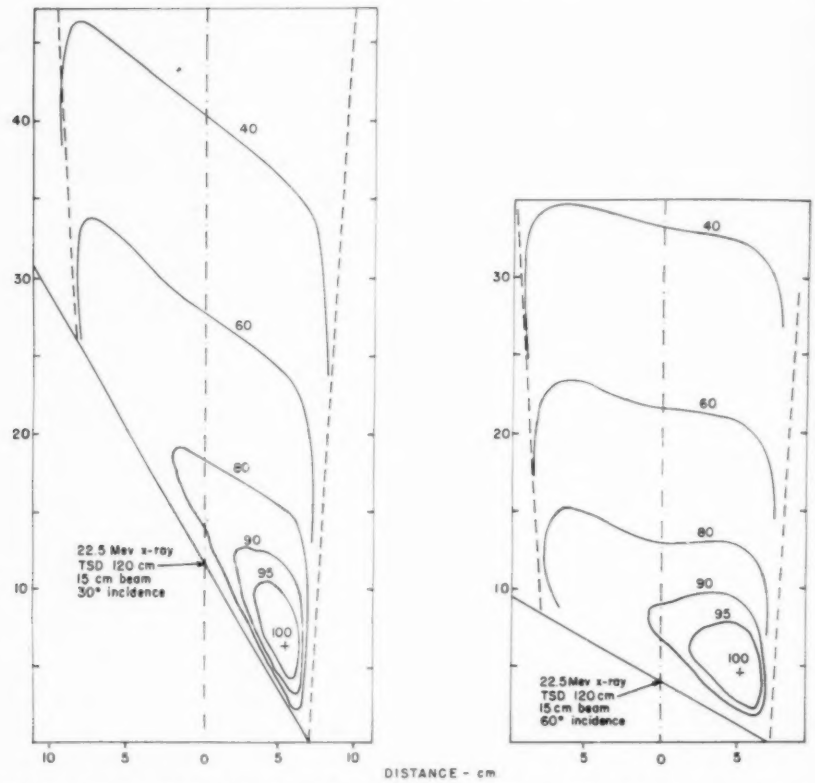


Fig. 11. Isodose distributions for angles of incidence of 30° and 60° and for a target distance of 120 cm. from the center of a 15 × 15 cm. field.

pensating filter for 22.5-Mev-peak x-rays from the betatron is described.

Depth dose measurements in water at target surface distances of 80 cm., 100 cm., and 120 cm. for fields ranging in area from 7 to 225 sq. cm. are presented. It was found that the absorption coefficient for 22.5-Mev x-rays in water varies linearly with the square root of the field size. A formula for determining the central-axis depth dose for the field sizes and target distances investigated is given.

Representative isodose curves for a number of fields at normal and oblique incidence are reproduced.

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SUMARIO

Distribución de la Dosis de Radiación en el Agua para Rayos X de un Máximo de 25.5 Mev

Se ha obtenido una serie de curvas de isodosis de la distribución de energía de la radiación producida por la absorción en agua de un haz de rayos X de un máximo de 22.5 Mev. Esta investigación se llevó a cabo con un registrador automático de isodosis que consta de cuatro aparatos: un amplificador de c.d. de doble vía, un aparato autoequilibrador de proporciones, un servomecanismo para regular la posición de un indicador-explorador en un fantasma de agua y un registrador para trazar la posición del indicador-explorador.

Las distribuciones en el agua, obtenidas con una pequeña cámara de yonización como indicador, han sido trazadas en forma de curvas de isodosis para campos rectangulares y circulares de tratamiento con secciones transversales, cuyo extensión varía de 7 a 225 cm.^{2}, y a distancias foco-superficie de 80 cm., 100 cm. y 120 cm. Además, se ofrecen típicas isodosis para campos de incidencia oblicua de 30° y 60°.

Se ofrecen patrones para el diseño de un solo absorbente diferencial que puede usarse con campos de todo tamaño.

La dosis profunda en el eje central para rayos X de 22.5 Mev a su máximo en la incidencia normal depende del tamaño del campo debido al esparacimiento lateral en el agua. Una fórmula empírica correlaciona la variación de la dosis a profundidad con los varios tamaños del campo y con las distancias foco-superficie que se usen.

DISCUSSION

Gail D. Adams, Ph.D. (San Francisco, Calif.): I must confess that when I was first asked to discuss this paper, I was a little nonplused. A discussion of isodose curves seemed inappropriate, in view of the usual type of paper delivered before this Society, particularly since the subject has been fairly well treated in the literature. It turned out that I didn't give enough credence to the fact that this work came from Memorial Center. In fact, the data reported in the literature have not been obtained with quite the precision necessary to arrive at some of the important results detailed here.

We in physics have sometimes been guilty of making unwarranted generalizations, and I am thinking at the moment of the character of scattered radiation. One is inclined to say that, for photons of energy in excess of a million volts, the scattering is forward. Although the secondaries tend to travel in this direction, the experiments reported indicate that the direction is not so much straight forward that side scatter can be neglected.

At the Radiological Laboratory of the University of California School of Medicine we are using 70-million-volt x-rays, for which the ranges of the secondary particles are much longer than at 20 million volts. This condition magnifies the effect described by Dr. Ovadia and requires considerable vigilance and investigation.

One other comment relates to the practice of making the edge of the x-ray beam of higher intensity than the center. This is what one must do in order to provide a uniform absorbed dose at a specified distance into the phantom, as is seen if we recognize that a part of the absorbed dose at a point is derived from photons originally traveling so as to miss that point. Thus, at the center of the x-ray field there may be an approximate balance between the amount heading toward the edge and the amount received from the edge. The edge, however, receives no dose from areas outside the field and not enough is received from the center to compensate, so that higher primary intensity at the edge must be provided in order to achieve a uniform absorbed dose at the depth in question.

The Present Status of Blue Cross and Blue Shield

Report of the American College of Radiology[1]

WARREN W. FUREY, M.D.

THE OFFICIAL program of the Forty-first Annual Meeting of the Radiological Society of North America calls for a "College Report on the Status of Blue Cross and Blue Shield" and, incidentally, a few other insurance programs. Thus I report: Both Blue Cross and Blue Shield are still with us and going strong, and so are we.

What are the current trends in the continuing attempt of the American College of Radiology to obtain the transfer of x-ray coverage from Blue Cross hospital insurance to Blue Shield medical insurance? First of all, this is a major College effort, which is being pushed on all fronts in every way possible; it is made necessary by the fact that the medical services in which we are so interested are almost universally carried in the hospital insurance plan and excluded from the medical insurance program.

As events today relate to this point, it can be said that the *status* is not *quo*. There are changes going on and some will need emphasizing to bring into focus those which we as radiologists and doctors should most enthusiastically approve. It should be understood that medical benefits must be available in Blue Shield before an attempt is made to remove them from Blue Cross. This view is supported by the Board of Chancellors; hence the effort of the College to broaden Blue Shield coverage to accomplish this end.

Radiology—and this includes x-ray diagnosis and/or therapy—is not lying amoldering in its Blue Cross grave. Consider this very brief listing of states in which Blue Shield plans have within the past few months incorporated coverage of our specialty in their medical insurance contracts. Massachusetts, Connecticut, Rhode Island, Indiana, Ohio, and Wisconsin have most recently and dramatically brought radiology into the protective fold of medical coverage as opposed to hospital coverage. Many others have had such coverage for a long time and some are now giving it serious consideration.

No doubt there are those who wonder why the insistence on this note of "radiology as a medical, not a hospital service." It is to be pointed out that this is the major issue behind the biggest single socio-economic headache in medical care today—the relationship between doctor and hospital and, in the case of our specialty, between radiologist and hospital administrator.

Before the worthwhile goals of the College through its individual officers and members can be achieved, it will be necessary first not only to establish firmly, in resolutions and definitions by the A.M.A. and legal authority, what is and what is not the practice of medicine, but also to show, in the practical language of insurance coverage, that radiology *is* the practice of medicine and that as such it *must* be covered by medical care insurance. Failing this, any victory achieved is one of words only, not of deeds.

So much for this insistence on *why* it is a real achievement to have more and more of radiology moving slowly but inevitably into the comfortable environs of Blue Shield and other medical care plans.

This awareness of a vital philosophical point in our disputes with the hospitals is being recognized in industry. The recent announcement by the General Electric Company of health insurance coverage for its employees, at a sizable outlay to the company, does not ignore the repeated plea of the radiologists. Radiology—and

[1] Presented at the Forty-first Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 11–16, 1955.

this includes x-ray services in the office—is provided as a medical benefit in such a way that the patient is better served, which, after all, is the basic philosophy of medical care plans.

The introductory paragraphs in the brochure on the plan point out that:

"Benefits are provided for a broad range of medical expenses for off-the-job accidents or sicknesses which strike you or your dependents. Basic medical expense insurance is provided for hospital, surgical, and diagnostic x-ray. In addition, extended medical expense insurance is provided for these and many other medical expenses—in a hospital, at home, or elsewhere—not covered by the basic insurance."

Later in the pamphlet, in a more detailed discussion, is the statement:

"Diagnostic x-ray examination insurance pays benefits equal to the actual amount charged, up to the maximum amount shown in the schedule for diagnostic x-ray examinations (excluding x-ray therapy) made in or out of the hospital in connection with an injury or sickness. . . ."

The attitude of General Electric in the enactment of this type of insurance coverage, with its particular reference to our specialty, should not go without our commendation. It is an example of industrial statesmanship, and our deep gratitude is due Mr. John Smith, General Manager of the X-Ray Division, for his educational efforts among his associates in the detailed negotiations leading to the final contract. Incidentally, much of the stimulus which brought about this program originated in suggestions from the College and College members.

There are other industrial insurance clouds on the horizons, with silver linings, too. One of these is in South Bend, Ind. At the Studebaker plant an insurance program has emerged from negotiations between the C.I.O. United Auto Workers and the Company management which has proved to be successful from the point of view of the local doctors, the Union, and the company alike. It is of special interest to radiologists that both hospital and office diagnostic and therapeutic benefits are provided.

The wording of the x-ray coverage is as follows:

"When the insured or any insured dependent necessarily receives an x-ray examination or laboratory examination on the recommendation and approval of a physician or surgeon legally qualified to practice medicine, the Association will pay the insured an amount equal to the fees actually charged for the services rendered but not exceeding the maximum amount shown in the schedule for the services rendered;

"Provided that in the event more than one such examination is received as the result of the same or related cause or causes or during any one period of disability, the total amount payable shall not exceed $50.00."

The fees listed are those agreed upon by the doctors of South Bend as being "average charges" for procedures without complications.

Radiologists practicing in South Bend have said that 80 per cent of the radiologic service under this plan, both diagnosis and therapy, is done in private offices. The exact figures as to the amount of work done by radiologists is not available, but the offhand appraisal of radiologists is that most of it is so done.

Let us turn now to some of the recently written Blue Shield insurance contracts, contracts which make those of us in the "insurance front lines" feel certain that progress is being made and that our cause is just. First consider Connecticut: Since March 1954, the Blue Shield Plan for Connecticut (Medical Service, Inc.) has offered a "preferred contract" to subscribers which includes diagnostic x-ray studies in the physician's office. After a year of watchful waiting coupled with close observation of experience data, the experimental effort is apparently headed toward a booming success. At present only diagnosis is covered, but indications point to the eventual inclusion of radiation therapy benefits.

An important feature thus far in the coverage is the $10.00 deductible provision, the subscriber paying to the examining doctor the first $10.00 of the fee schedule for x-ray diagnostic procedures, with an annual total payment limitation of $50.00.

However, plan officials have already indicated there is a good possibility that the $50.00 limitation may be dropped.

The Executive Director of Connecticut Medical Service, Inc., wrote as of March 15, 1955, that the x-ray coverage was the most attractive provision of the Preferred Contract so far as group enrollment was concerned. He went on to say that they had only begun to experience utilization of the x-ray program and he felt that eventually its cost would be very close to the calculated rate. He further stated:

"We think the program is fulfilling our hopes for it, providing satisfactory coverage to our members and a sound underwriting risk. Our experience so far indicates that approximately 50 per cent of the benefits paid are for the services of certified radiologists and the balance for the physicians in other types of practice.

"As a word of caution, I do not believe the program would be satisfactory if we did not have the particular wording in our contract which eliminates physicians' offices located in hospitals."

Some even more interesting language is included in the recently announced coverage of radiology in Massachusetts Blue Shield. Their radiology rider reads:

"Any member covered by this rider who is a non-hospitalized patient shall be entitled to full credit from Blue Shield for any x-ray examination or laboratory determination:

"(1) that is undertaken immediately following an accident to determine the extent of a resultant acute injury or that is undertaken subsequent to an accident to determine the current status of a recent fracture except that no credit in excess of $50.00 per member shall be provided in connection with any one accident;

"(2) that is undertaken to determine the relationship between fetus and pelvis during current pregnancy;

"(3) that is undertaken in conjunction with a laryngoscopy, bronchoscopy, esophagoscopy, gastroscopy, cystoscopy, myelography, or a similar major diagnostic procedure;

"(4) that is undertaken within ninety days following discharge from the hospital to determine the current status of the condition for which the member was treated while in the hospital except that no credit shall be provided for more than two such examinations in connection with any single period of hospitalization."

Blue Shield in Indiana and Rhode Island Physicians' Service are both enjoying pleasant experiences with limited diagnostic x-ray coverage in physicians' offices or in hospitals. These pioneering trial runs are providing valuable information which may well serve as a pattern to other more timid plans across the country. They should be encouraged and we should do everything possible to cooperate with them and to prevent excess usage and other abuses.

Time and space do not permit discussion of other recent developments. Those presented are a representative cross section of some of the significant changes already effected—accomplishments in which the College has participated in every way possible.

There are other activities of tremendous import to the welfare and well-being of our people, which deserve at least superficial consideration at this time because of their national character and anticipated scope. Turn your attention for the moment to the pending insurance which is to be written for the millions of employees of the Federal Government. Here, as in other areas, the College has been active and (we feel) helpful to civil service administrators in acquainting them with the rationale and goals which motivate its actions.

Right now the Civil Service Commission, which will be the arbiter of the insurance for Government employees, is listening to various spokesmen set forth their ideas as to what the insurance should include and what it should not include. Blue Cross, Blue Shield, cooperatives, private carriers, hospital and medical organization representatives, and a host of other interested organizations and individuals are participating actively in the deliberations.

The able representative of the College has been Dr. T. J. Wachowski, Chairman of the Commission on Legislation and Public Policy. Dr. Wachowski has told the civil service people in his Commission's detailed recommendations:

"Radiation therapy services should be included in medical care insurance programs on a scheduled basis similar to surgery for the following reasons:

"(1) The motivation for establishing medical care insurance coverages has been to assist individuals to

pay expenses involved in medical care, particularly expenses that occur at a time or in a situation when the individual or family budget is in a weakened position. Many conditions requiring radiation therapy meet this criterion.

"(2) A primary purpose in establishing medical care insurance coverages is to make it economically possible for the insured individual to obtain the treatment necessary to cure or alleviate the condition facing him. Some conditions which are patently serious and individually expensive to treat are responsive only to radiation. In other conditions radiation therapy is the treatment believed to be best by physicians.

"When an insurance plan covers only alternate and less desirable methods of treating such conditions, the plan is economically dictating or at least prejudicing the treatment to be rendered.

"(3) A motivation in establishing medical care insurance plans has been to provide adequate medical and surgical coverage to the insured group. A plan cannot be considered to be adequate if it lacks radiation therapy benefits in that radiation therapy and surgery, acting independently or in concert, are utilized in the treatment of nearly all cancers.

"(4) A medical care insurance plan should attempt to encourage the insured individuals to avoid hospitalization. The elimination of unnecessary hospitalization works to the benefit of the insured group in that it releases funds that would be utilized for such unnecessary hospitalization either for more hospitalization in necessary cases or for further medical care benefits.

"Much radiation therapy can be conducted on an ambulatory basis without hospitalization. This is advantageous not only to the insurance plan as an entity but to the insured patient in that he loses a minimum of time away from his work and family.

"(5) Radiation therapy can be included in medical care insurance at a low cost."

Dr. Wachowski also discussed with the Civil Service Commission some phases of the physician-hospital controversy, particularly in the area of radiological diagnosis. He said:

"We would urge that radiology, pathology, anesthesiology and psychiatry, if included within the scope of this insurance plan, be included whether rendered and charged for as hospital services, or as medical services. If they are included only as hospital services, which we may reasonably judge to be the present intent, the Federal Government will in effect be espousing the proposition that hospitals (which are in the main corporations) should sell medical services. This is contrary to the laws of most States.

"Only recently the Iowa District Court has upheld the State Medical Association on the illegality of the hospital (or corporate) practice of medicine."

This was followed by an excellent historical account of various court decisions, opinions of many attorney generals across the country, the A.M.A. House of Delegates actions, and other expressions supporting the principle that anesthesiology, pathology, psychiatry, and radiology are the practice of medicine.

In conclusion Dr. Wachowski said:

"We respectfully urge that if the benefits cited are to be provided, they be provided both as a part of hospital care and as a part of physician care. If provided only as a part of hospital care as in the present legislation, the Federal Government:

"(1) will be providing insurance benefits that will be available to certain Federal employes but will not be available to others;

"(2) will be offering insurance benefits that cannot be provided in many States without violation of State law;

"(3) will be providing insurance benefits that will be used to foster the practice of medicine by hospitals through the employment of physicians by hospitals which will retail the services of these physicians to insured civil service employes;

"(4) will be definitely placing the Federal Government on the side of hospitals in this physician–hospital difference of opinion."

These thoughts of Dr. Wachowski and his Commission are quoted because they help us to understand what the issues are and also underline the important role being played by the College. There is a need for your sustained support and interest in College affairs so that *your* point of view can be placed forcefully and intelligently at the highest levels of social, economic, and political influence. We do not know what the outcome of this proposal will be. We have done our part and we are hopeful.

So much for things accomplished or in the process of accomplishment. Now briefly to two proposals presently being considered by the plans, one the matter of extended health benefits, the program formerly classified as "catastrophic coverage," the other the matter of national enrollment.

A special Blue Cross-Blue Shield Committee on Extended Benefits has prepared a document to serve as a reference and general guide in setting up an extended benefits contract. This contract proposal is simply an extension of present Blue

Cross-Blue Shield programs utilizing an endorsement approach. The proposal provides coverage for hospital and professional services of the physician for a period of seven hundred and thirty days over the basic Blue Cross-Blue Shield contract. Of special interest to radiologists are the provisions for coverage of x-ray studies, radiation therapy, laboratory examinations, and physical therapy. These are covered by a combined deductible and coinsurance feature, as follows:

1. *X-ray, Radiation Therapy, Laboratory Examination and Physical Therapy in Hospital Out-Patient Department:* A member referred by a physician in private practice to the out-patient department of an Acute General Hospital for services not otherwise provided for in the Hospital Basic Subscriber Certificate or this Endorsement shall be entitled during any benefit period to 80 per cent of all charges for x-ray examinations, radiation therapy, laboratory examinations, and physical therapy, in excess of $10.00 per month, in accordance with the *hospital's* established schedule of charges for such service.

Then under another and certainly very acceptable title:

2. *Professional Services, Including X-ray Examinations, Radiation Therapy, Laboratory Examinations, and Physical Therapy:* During any benefit period a member shall be entitled to x-ray examinations, radiation therapy, laboratory examinations, or physical therapy when authorized by the attending physician to the extent of 80 per cent of all charges for these services in excess of $10.00 per month, in accordance with the fee schedule on file at the office of the Plan. Any maximum benefit stated in the Medical/Surgical Basic Subscriber Certificate is hereby waived.

The language in the last paragraph guarantees Blue Shield coverage of professional services of a physician wherever rendered, thus fulfilling one of the aims of the College to the satisfaction of all.

One more significant Blue Cross-Blue Shield joint effort is the matter of National Enrollment. This has been a subject of much discussion because the lack of uniformity of Blue Cross and Blue Shield contracts has resulted in a loss of some national accounts. It is generally agreed that Blue Cross and Blue Shield cannot survive without national accounts; hence, a Special Committee on National Enrollment in cooperation with fifty-two Plan Executive Directors has developed a proposal for coverage of national accounts.

The proposal presents a rather detailed general program, some of which applies directly to our specialty. The language of the original proposal, not entirely to our liking, has been changed to some extent at our suggestion. In our opinion, further changes are required. These changes are necessitated by the fact that the National Blue Cross Contract will almost certainly include radiology along with anesthesiology, pathology, and psychiatry as hospital services, and these may or may not be covered by Blue Shield as Medical Services. This "may or may not" problem depends upon the definition and interpretation of the word "offer" as contained in the following sentence:

"In each of the two programs outlined above [referring to provisions for both Service and Indemnity type programs] the following segments must be *offered* by individual plans."

These segments include

(1) Surgical services,
(2) Obstetrical services,
(3) In-hospital medical services,
(4) Related anesthesia services,
(5) Diagnostic x-ray services, x-ray therapy, radium or radon therapy, and isotope therapy when rendered by a doctor of medicine who customarily bills for his services,
(6) Professional laboratory interpretation, and
(7) Physical therapy.

Superficial observation of this portion of the proposal might well lead one to applaud the purpose and intent. Certainly the manner of providing these benefits meets with our approval. The matter of *offering* the services rather than including them, however, creates the problem.

The proposal has been submitted to the Plans for consideration, and approval, in principle, has been accorded by a goodly number. Some, however, have either not approved or have approved with qualifications. Of the latter, Illinois Medical Service—the Blue Shield Plan operating in Illinois with headquarters in Chicago—has studied the program and requested an

amendment to the title, "Scope of Benefits," to read as follows:

"In each of the two programs outlined above the following segments must be offered by individual plans, and whenever any or all such segments are included in a hospitalization contract concurrently offered to a purchaser, then such segment or segments must be included in the Blue Shield Contract made available to such purchaser."

In other words, professional services of a doctor of medicine must be included in the medical insurance contract and thus properly qualified as a medical service when so rendered.

This amendment was considered by the Blue Shield Commission at its meeting in Boston on Nov. 26 and 27, 1955, and acted upon favorably. The proposal with the amendment will again be offered to the individual Plans for consideration and action.

Those of you who are in any way associated with local Plans are urged to use your influence with those Plans and with their Boards of Trustees to secure support of these new proposals. Approval of the amended proposals would go a long way toward settling at least a portion of the overall problem created by long-existing Blue Cross-Blue Shield differences.

I hope that from this rather detailed résumé of progress you have a better idea of the functions of the American College of Radiology in this important area of medical economics. But important as the contributions of the College are, they would avail little were it not for the dedicated members of our specialty who in their local areas are participating directly in the policy direction of insurance coverage. It is with these individuals who sacrifice their time and their pocketbooks by serving on Blue Shield organizations that our progress and future hopes most definitely lie.

It would be fitting to name the individuals in medicine generally, and in radiology in particular, who have contributed so ably and so generously to our cause. However, the list is long. Suffice it to say we are grateful to all who have participated and look forward hopefully to wider support in the not too distant future.

In closing, a movie producer in the wonderland that is Hollywood once said "America is a 'happy ending' country." Let us hope that this holds true in relation to continuing progress toward the identification of radiology as the practice of medicine in respect to insurance contracts.

104 S. Michigan Ave.
Chicago, Ill.

EDITORIAL

Presidential Address
(Radiological Society of North America)[1]

Not long ago I heard an address entitled, "Radiologist—Quo Vadis?" Then I read an article entitled "General Practitioner—Quo Vadis?" And I asked myself the same question: Where *are* we, as radiologists and doctors, going?

In order to find out in what direction we are headed, it is necessary first to establish our present position and to figure out how we happened to arrive at this point. This means a study of history—the history of our community, our state, our country, and of the world, the history of medicine, and the history of radiology—not from the standpoint of bringing back the good old days but for the light it will throw upon the present and the future.

We worry about Federal medicine and write volumes opposing it. We face, in my opinion, many other, more serious problems. It is here that history helps us understand our present position. Medical men built and developed hospitals. The first hospital in the United States was founded by Thomas Bond and Benjamin Franklin. But after laying the ground work for our magnificent hospitals, we gradually gave up our responsibility for their operation and our participation in their management. The present situation is summed up by a statement of the National Hospital Association: "Diagnosis, treatment and the care of the ambulatory sick become increasingly the functions of the hospital as it develops into the center of community health activities." If hospitals are short-circuiting the family doctor, say their spokesmen, they do it only in the interest of greater efficiency and lower rates.

As doctors we aided in the establishment and growth of the Blue Cross, which has helped to make hospitals independent of the medical staff members. Doctor W. D. Abbott, Chairman of the Committee on Medical Practice in Hospitals, of the Iowa State Medical Association, says the hospital-physician controversy in Iowa dates back to the introduction of the Blue Cross comprehensive contract late in 1949, providing full payment for medical services such as radiology, pathology, and anesthesiology. These services are billed by the hospital. But in this, as Dr. Abbott points out, the contract is discriminatory, since it does not cover the services of a doctor of medicine, who does not accede to being classified as a hospital employee. This could have been adjusted, but the Iowa Hospital Association refused to concede that radiological and pathological services contribute to the diagnosis and treatment of illness and thus constitute the practice of medicine.

As doctors we sponsored voluntary health insurance, which is now so strong that the insurance companies set the medical and surgical fees for us. Two cardinal principles of the practice of medicine are that the choice of a physician be free and that there be no third party between the patient and the physician. We advocated voluntary health insurance to eliminate the so-called need for Federal medicine. A few evenings ago I heard a talk by an insurance executive, formerly a practicing

[1] Delivered at the Forty-first Annual Meeting, Chicago, Ill., Dec. 12, 1955.

physician, explaining a new type of policy that his company was planning to offer to the public in the near future. His title was "The Third Party in the Practice of Medicine." As the third party enters, the free choice of a physician becomes less important.

We can learn much through the history of labor unions. These organizations are probably setting the pattern for the kind of sickness insurance we will have in the future. Remember, what the public wants the public gets. So, while we watch the front door to keep out Federal or socialized medicine, various other groups, for their own selfish interests, are quietly slipping in through the back door. We have made great scientific strides and are able to control the wonder drugs and vaccines and to man new and powerful apparatus. Our lack of interest in hospital affairs and our experiments in economics may be very costly.

I do not believe it is too late for the radiologist to take some action. We are, however, a minority within a minority. One doctor to 770 people, one radiologist to 70 doctors! When we consider Doctor Deaver's statement that it takes 17 specialists to make a doctor, we realize anew how definitely a minority we are. Under these conditions, what can we do? The old saying still holds: "If you can't whip 'em, join 'em."

My advice to the radiologist is: Take an active part in your radiological society and in radiological affairs, both local and national, but remember that you are a doctor and be active also in your local medical society. Attend regularly, take part in discussions, serve on committees, and if you can't get someone else to blow your horn, blow it yourself. Show your interest, ability, and aggressiveness. In other words, help make radiologists the leaders in local and state medical societies and the American Medical Association, not as specialists but as doctors, remembering that the general practitioner is still the backbone of medicine, and that if he is broken, medicine as we know it will die.

The science of medicine has made great strides; the art of medicine has declined. We must devote a greater effort and a more careful study to socio-economics. We cannot ignore history. At present we are a privileged profession, but we must remember that with every privilege there goes a responsibility. Let us ask ourselves if we are living up to our responsibility. Again, we must devote more time and energy to our medical organizations—not as specialists, but as doctors.

The day of the one-man show is past. If the medical profession does not work together, the words of Edmund Burke will find fresh confirmation: "When bad men combine, the good must associate; else they will fall one by one, an unpitied sacrifice in a contemptible struggle."

THOMAS B. BOND, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN RADIUM SOCIETY

The Annual Meeting of the American Radium Society will be held at the Shamrock Hotel and M. D. Anderson Hospital, Houston, Texas, April 9–11, 1956.

GREATER MIAMI RADIOLOGICAL SOCIETY

At a recent meeting of the Greater Miami (Florida) Radiological Society, the following officers were elected: President, Dr. Raymond Parks; Vice-President, Dr. Richard Shapiro; Secretary-Treasurer, Dr. André S. Capi, 300 N. 20th Ave., Hollywood, Fla.

THE GREATER SAINT LOUIS SOCIETY OF RADIOLOGISTS

The following officers were elected at the meeting of the Greater Saint Louis Society of Radiologists, held on Jan. 25, 1956: President, Charles Nolan, M.D.; Vice-President, William B. Seaman, M.D.; Secretary-Treasurer, Sam J. Merenda, M.D., 45 Berry Road Park, Glendale, Mo.

ROCHESTER ROENTGEN RAY SOCIETY

At the annual banquet of the Rochester (N. Y.) Roentgen Ray Society, held on Jan. 23, 1956, the following officers were elected for the coming year: President, George H. Ramsey, M.D.; Vice-President, Charles E. Sherwood, M.D.; Secretary-Treasurer, T. Paul Guest, M.D., 277 Alexander St., Rochester, N. Y.

TORONTO RADIOLOGICAL SOCIETY

The Toronto Radiological Society has announced plans for the Four-City Meeting for 1956, to be held at the Royal York Hotel in Toronto, April 28. The registration fee will be $10.00 per person. Requests for hotel reservations should be addressed to Mr. G. R. Street, Convention Manager, Royal York Hotel, 100 Front St. W., Toronto, Ontario, Canada.

FREEDMAN LECTURES UNIVERSITY OF CINCINNATI

On Saturday and Sunday, April 28 and 29, 1956, Dr. J. Stauffer Lehman, Professor of Radiology, Hahnemann Medical School, and Director of the Department of Radiology, Philadelphia Hospital, will deliver the eighth annual Joseph and Samuel Freedman Lectures in Diagnostic Radiology at the University of Cincinnati College of Medicine. Radiologists desiring to attend should write Dr. Benjamin Felson, Cincinnati General Hospital, Cincinnati, Ohio, for further details.

INTERNATIONAL LIBRARY OF STRATIGRAPHY

The staff of the recently founded International Library of Stratigraphy, directed by Prof. A. Vallebona, will gratefully receive copies or reprints of publications concerning stratigraphy sent as a gift. These may be addressed to Dr. Luigi Oliva, Istituto di Radiologia della Università, Ospedale S. Martino, Genoa, Italy.

Letter to the Editor

To the Editor of Radiology

DEAR DR. DOUB:

In reply to a number of requests from viewers of my scientific exhibit on the small intestine (at the Forty-first Annual Meeting of the Radiological Society of North America, in December 1955), I would like to provide some information about the recommended contrast medium.

Carboxymethylcellulose was reported by Kirsh and Spellberg (Radiology **60:** 701–707, 1953) to be of value for improving the stability of the suspension of barium sulfate, and preventing its flocculation in the small bowel. Since that report was published, our method of preparation of the medium has been changed and the radiographic results have become more consistent.

Sodium carboxymethylcellulose is purchased from Hercules Powder Co., Wilmington, Del., as "cellulose gum (C.M.C.)." It can be obtained in different degrees of viscosity. The type we have used (70-High, Premium Grade) has a viscosity of 1,300 to 2,200 centipoises in 1 per cent solution, at 25° C.

The hospital pharmacist prepares the contrast medium as follows:

1. A 1 per cent solution of sodium carboxymethylcellulose (C.M.C.) is made as follows: The powder is added slowly to about half the required amount of hot distilled water, which is being agitated in an electric mixer so that no lumps are formed. Cold water is then added to bring the solution to 1 per cent. (This will keep for months, refrigerated.)
2. Water (5 ounces) is stirred into the barium sulfate powder (4 ounces by volume). This makes 6 ounces (by volume) of barium-water suspension.
3. To this are added 2 ounces of the 1 per cent C.M.C. solution. This is stirred. The result is 8 ounces of barium-water suspension containing 0.25 per cent C.M.C.

I. E. KIRSH, M.D.
VA Hospital
Hines, Ill.

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

CHEST X-RAY DIAGNOSIS. By MAX RITVO, M.D., Assistant Clinical Professor of Radiology, Harvard Medical School; Instructor in Radiology, Tufts Medical School; Lecturer on Radiology, Boston University School of Medicine; Roentgenologist-in-Chief and Director, Department of Radiology, Boston City Hospital; Associate Radiologist, Beth Israel Hospital, Boston, Mass.; Radiologist, Memorial Hospital, Roxbury, Mass.; New England Sinai Hospital for Diseases of the Chest. A volume of 640 pages, with 633 illustrations and a color plate. Published by Lea & Febiger, Philadelphia. Second Ed., thoroughly revised, 1956. Price $16.00.

THE THYROID. A Fundamental and Clinical Text with Sixty Contributors. Edited by SIDNEY C. WERNER, M.D., Sc.D. (Med). A volume of 790 pages, with 130 illustrations and 65 tables. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York, N. Y., 1955. Price $20.00.

THE BLOOD-BRAIN BARRIER, WITH SPECIAL REGARD TO THE USE OF RADIOACTIVE ISOTOPES. LOUIS BAKAY, M.D., F.A.C.S., Instructor in Surgery, Harvard Medical School; Assistant in Neurosurgery, Massachusetts General Hospital, Boston, Mass. A monograph of 154 pages, with 32 illustrations and 10 tables. Published by Charles C Thomas, Springfield, Ill., 1956. Price $5.50.

CAUSAL FACTORS IN CANCER OF THE LUNG. By CARL V. WELLER, M.S., M.D., Chairman of the Department of Pathology and Professor of Pathology in the Medical School, and Pathologist to the University Hospital, University of Michigan, Ann Arbor, Mich. The Beaumont Lecture, Wayne County Medical Society, Feb. 7, 1955. A monograph of 114 pages, with 20 figures and 12 tables. Published by Charles C Thomas, Springfield, Ill., 1956. Price $3.00.

MEDICAL PHOTOGRAPHY. RADIOGRAPHIC AND CLINICAL. By T. A. LONGMORE, Hon. F.S.R., Principal, Kodak School of Medical Radiography and Clinical Photography; Hon. Editor of "Radiography"; Member of Council, Education Committee and Board of Examiners of the Society of Radiographers; Late Senior Instructor in Radiographic and Medical Photography at the Royal Army Medical College, etc. Foreword by Brigadier D. B. McGrigor, O.B.E., M.B., Ch.B., D.M. R.E., Hon. F.S.R., Consulting Radiologist, The War Office; President, British Institute of Radiology, 1939–42. A volume of 990 pages, with 76 plates, 320 text figures, and 95 tables. Published by The Focal Press, London. Fifth Ed., 1955. Distributed in the United States by The American Photographic Book Publishing Co., Inc., 33 West 60th St., New York 23, N. Y. Price $15.00.

RADIODIAGNOSTIC EN OPHTALMOLOGIE. By EDWARD HARTMANN AND EVELYN GILLES. A volume of 412 pages, with 497 illustrations. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris. Price 5.000 fr. (Cartonné toile 5.700 fr.).

LA TOMOGRAPHIE AXIALE TRANSVERSALE. ÉTUDE THÉORIQUE. APPLICATIONS CLINIQUES. By GÉRARD BONTE, Electro-Radiologiste des Hôpitaux de Lille, GÉRARD TRINEZ, Electro-Radiologiste de l'Hôpital d'Amiens, and MICHEL BRENOT, Ingénieur E.B.P. Preface by Professeur Charles Gernez-Rieux, membre de l'Académie Nationale de Médecine. A monograph of 166 pages, with 135 illustrations. Published by G. Doin et Cie, Éditeurs, 8, Place de l'Odéon Paris, 1955. Price 2,200 fr.

VERTEBROPATIE SEGMENTARIE RARE. By ROBERTO GHISLANZONI AND GIUSEPPE PORRO, Istituto di Radiologia della Università di Genova (Dir. Prof. A. Vallebona). A volume of 204 pages, with 99 illustrations. Published by Edizioni Minerva Medica, Genova, 1956.

Book Reviews

THE SKIN. A CLINICOPATHOLOGIC TREATISE. By ARTHUR C. ALLEN, M.D., Associate Pathologist, Memorial Hospital; Associate Attending Pathologist, Memorial Cancer Center, New York City; Associate Professor of Pathology, Cornell University Medical School, Sloan-Kettering Division; Consultant Pathologist, Bronx Veterans Administration Hospital and New York Infirmary. A volume of 1,048 pages, with 495 full-page illustrations and a frontispiece in color. Published by C. V. Mosby Co., St. Louis, 1954. Price $25.00.

In passing judgment on this book on the skin and its diseases, it is necessary to take into account the fact that it is addressed primarily to the general pathologist, though the practicing physician and the dermatologist, the author believes, will also find it of interest. He is himself a pathologist; he has organized his material on a pathological rather than a clinical basis, and the discussion of this aspect of the dermatoses is excellent.

When it comes to the clinical phases of dermatology, the author is on less familiar ground, and he makes no claim to the originality of the observa-

tions recorded. It is to this portion of the book that his reference to "assembling" rather than "writing" the text is particularly applicable. The opinions which he expresses are from the literature, which he appears to have quoted satisfactorily.

The style of writing is excellent, and the descriptions and discussions are easily followed. Usually the author's position emerges clearly, though sometimes at the expense of a little oversimplification. This tendency to simplify the grouping of diseases is likely to be welcomed by the more casual reader and is not objectionable so long as he is sufficiently familiar with the subject to appreciate what conditions are being lumped together in any given discussion.

The coverage of the various diseases is fairly good, though limited. No attempt at any extended consideration of therapy has been made. For this the author frankly refers his readers to other texts.

The mechanics of the book are all that one might desire. The printing is good and the paper and binding are excellent. The two-column format has been used, and the illustrations occupy separate pages, so that the text is not broken up by pictures, all of which makes for ease of reading. The index, though not so full as that in some of the standard works, is adequate, and references to the literature are ample.

PÄDIATRISCHER RÖNTGENATLAS. EINE SAMMLUNG TYPISCHER BILDER. By DR. M. A. LASSRICH, PROF. DR. R. PRÉVÉT, and PROF. DR. K. H. SCHÄFER, Hamburg. Edited by Dr. K. H. SCHÄFER. A volume of 334 pages, with 700 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N. Y. Price DM 115.—($27.40).

The authors have assembled a collection of 700 illustrations covering most common and many unusual conditions seen in children. It is obviously impossible to include everything, since practically every condition found in adult life occurs also in childhood, plus a host of conditions peculiar to this early age group. The illustrations are accompanied by brief but adequate clinical notes, roentgenologic descriptions, and frequently descriptions of the pathologic specimens. As is to be expected, tuberculosis looms large in the case material.

The book is divided into three parts: Part I, Thoracic Organs; Part II, Abdominal Organs; Part III, The Skeletal System. The normal with its variations, as well as the abnormal, is considered.

Specialized contrast methods are briefly dealt with, such as encephalography, retroperitoneal air insufflation, and angiocardiography, but the treatment which they are accorded serves only as an introduction to these technics.

It is doubtful that a book of this nature can replace a soundly constructed textbook dealing with the principles of pediatric roentgen diagnosis, and its usefulness for the experienced roentgenologist may be questioned. It would certainly be of value, however, in a teaching department for ready reference. The illustrations are of uniform excellence, and many have accompanying sketches. The details of printing and manufacture are of the standard of excellence that we have come to expect from the publishers.

DIE OCCIPITO-CERVICAL-GEGEND. EINE DIAGNOSTISCH-PATHOGENETISCHE STUDIE. Fortschr. a. d. Geb. d. Röntgenstrahlen, Ergänzungsband 74. By Priv.-Doz. Dr. J. E. W. BROCHER, Genf. A volume of 146 pages, with 185 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N. Y. Price DM 48.—($11.40).

In contrast to the lumbosacral region, injuries and anomalies of the occipital bone, atlas, and axis are relatively rare. Upper cervical lesions can nevertheless have great clinical significance. Multiple sclerosis, syringomyelia, and amyotrophic lateral sclerosis have been diagnosed when the symptoms actually depended upon a local condition in the occipito-cervical area.

Dr. Brocher opens his monograph on this region with chapters on the embryology, anatomy and x-ray examination, following these with details of his original work concerning the movements of the upper cervical vertebrae. The longest and most detailed chapter in the book is that regarding basilar impression, assimilation (or occipitalization) of the atlas, os dentoideum separatum, congenital dislocation, occipital vertebra and aplasia of the clivus. These developmental anomalies, while of varying significance in terms of frequency of occurrence, may be of extreme importance to the patient because of their lethal possibilities. Diagnostic accuracy is here essential if one is to obtain the full benefit of modern manipulative and surgical procedures. Minor structural variants, such as the foramen arcualis, the paracondyloid process, and the processus supratransversarius atlantis, are also illustrated.

Some conditions of controversial nature clinically, such as the spontaneous subluxation of the atlas of Hadley, the Grisel syndrome, and the borderline degenerative changes of atlas and axis, are quite honestly presented and discussed. The chapter dealing with inflammatory disease, tuberculosis and tumors is rather brief for, as is understandable, the case material available is limited.

The final subject to be considered is fractures and fracture dislocations. With increased knowledge of first aid, more and more of such patients are surviving immediate injury to reach the hospital and possible definitive care. The author might have given his text a more general usefulness had he here entered into the practical aspects of the treat-

ment of these injuries. As it is, the monograph is still a worth-while purchase for neurologists, orthopedic surgeons, and radiologists.

LUNGENKREBS UND BRONCHOGRAPHIE MIT UNTERSUCHUNGEN ÜBER URSPRUNG UND URSPRUNGSBEDINGUNGEN DES BRONCHIALKARZINOMS. Fortschr. a. d. Geb. d. Röntgenstrahlen, Ergänzungsband 75. By Dr. H. ANACKER, Dozent an der Justus-Liebig-Hochschule, Giessen. A volume of 78 pages, with roentgenograms, photographs, schematic drawings, and tables. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N. Y. Price DM 28.50 ($6.80).

This monograph on cancer of the lung and bronchography is based on a study of over 500 bronchographic films of proved cases of pulmonary carcinoma. The author's technic calls for a systematic bronchographic study of any area of the lungs which, on the scout film or on the tomogram, raises the question of possible malignant invasion. He uses catheters variously designed for corresponding sections of the bronchial tree. As in catheterization of the heart, the catheter is introduced under fluoroscopic control into the involved bronchus. Following injection of the medium, the changes (partial or complete obstruction, irregularity of outline, erosion of the walls, narrowing of the lumen, displacement or distortion of the bronchus, etc.) are carefully observed and a permanent record is made by means of aimed spot films in various projections. The degree of mobility with respiration and coughing or any existing fixation is carefully recorded. In this manner, it was possible to make a positive diagnosis in 82 per cent of the cases.

The author is a firm believer in the theory that the most common cause of cancer is the smoking of cigarettes. He has studied under the microscope the distribution and the size of the tar-containing particles of cigarette smoke. A study of the aeromechanics of the bronchial tree and its ramifications seems to show that aerial whirlpools develop at the site of the ostia of the segmental bronchi (mainly the sixth on the right side) and that the greatest number of particles are deposited there. These ostia of the segmental bronchi are exactly the area in which, according to the experience of the author, bronchogenic carcinoma always arises.

Schematic drawings of the main bronchi, lobar bronchi, and segmental ramifications show practically all possible localizations of bronchogenic carcinoma. Excellent reproductions of the most important bronchographic findings are presented. The test is concisely and simply written. The surgical indications are briefly discussed.

Any physician doing bronchographic work should find interesting points and some inspiration for further study in this neat little monograph.

ANATOMIE RADIOLOGIQUE NORMALE. OPTIQUE RADIOLOGIQUE ET DÉPISTAGE DES ERREURS DE LECTURE DES CLICHÉS. By HENRY TILLIER, Professeur Agrégé à la Faculté, Électro-radiologiste des Hôpitaux d'Alger. A book of 258 pages, with 375 figures. Published by G. Doin & Cie, Paris. Second Ed., revised and enlarged, 1955. Price 2,600 fr.

Professor Tillier introduces this monograph on normal radiologic anatomy with a review of the principal laws of radiologic optics, namely, the phenomena concerning conical projection of the roentgen beam, confusion of planes, atomic number and density, and tangential incidence of the beam. These laws are discussed and precautions are cited to avoid general errors in roentgenographic interpretation.

The succeeding chapters include detailed descriptions of anatomy as it is depicted on the roentgenogram. The skeletal system is given special attention and, as each section is described, the chief errors to be avoided in interpretation are listed. The chapters on the chest, digestive tract, and urogenital system are less detailed, but follow the same general plan. Differences between the infant, growing child, and adult are stressed.

The illustrations all take the form of diagrammatic sketches. These are excellent, but actual reproductions of a few roentgenograms would probably make the monograph more practical.

PRÉCIS DE TECHNIQUE RADIOLOGIQUE. By A. NÈGRE and F. ROUQUET, Anciens assistants d'électro-radiologie du Val-de-Grâce. Preface by M. le Professeur Didiée. A volume of 344 pages, with 259 figures. Published by G. Doin & Cie, Paris. Third Ed., completely revised, 1955. Price 2,600 fr.

The clarity of exposition, the excellent illustrations, and the variety of material covered in this text on roentgenographic technic have assured it a well deserved popularity in French speaking territory. The first part, on Physics (114 pages), by Nègre, includes only the simplest mathematical formulae, but at no sacrifice of comprehensiveness. The technical section, by Rouquet, covers general considerations (31 pages), positioning for views of skeletal structures (94 pages) and of organs, including contrast procedures (55 pages), and finally miscellaneous matters (41 pages), such as pediatric problems, emergency conditions, and choice of electrical factors, radiation dosage at skin level during diagnostic procedures, and roentgen localization of foreign bodies.

As is to be expected, the eponyms are largely of European origin. Thus, instead of Towne's or Waters' views, one finds Bretton, Chaumet, Grashey, Hirtz, or Worm's projections. The inverse proportionality between radiation intensity and the square of the distance is called Kepler's law. Some

unusual technical details are given, *e.g.*, the use of pliable intrarectal or intravaginal films for visualization of the coccyx. Porcher's method of barium meal examination after morphine injection, Caroli's "biliary radiomanometry" (cholangiography through the T-tube with concomitant pressure readings), and selective bronchography utilizing the catheter of Métras, are described, but angiocardiography receives only a few incidental lines, and arteriography and phlebography are not even mentioned. The phototimer is considered a recent development, costly and seldom used, but promising for the future. High-kilovoltage technics are not discussed (although such equipment is available from French manufacturers).

The authors regard 1.0 mm. Al filtration as a standard requirement for diagnostic apparatus. They give the "tolerance exposure" as 0.033 r per hour (which amounts to 1,320 mr in a forty-hour week), but do not recommend exceeding one-tenth of this amount—the so-called "safe dose" (132 mr per week).

LA PNEUMOGINECOGRAFIA. By F. MARCHESI, L. OLIVA, V. ALBANO, AND M. MANESCHI. Divisione Ostetrica e Ginecologica degli Spedali Civili di Genova, and Istituto di Radiologia dell' Università di Genova. A volume of 134 pages, with 77 illustrations. Published by Edizioni Minerva Medica, Torino, 1955.

The authors have studied the pelvic canal of numerous patients following intraperitoneal injections of gas. They begin this monograph with a general section which is concerned with the anatomy of the female internal sex organs, the indications and contraindications to gas injection, and the dangers of the procedure. Special sections follow, dealing with the normal appearance, developmental anomalies, inflammatory processes, postoperative changes, neoplastic conditions, pregnancy, and the uses of the procedure in infancy. In conclusion, they attempt an evaluation of this radiographic technic and compare it with other methods of investigation.

This monograph is illustrated with many radiographs. The authors have employed stratigraphy freely and believe that it enhances the value of the procedure. Intraperitoneal air was often used in combination with uterosalpingography with excellent results.

PNEUMO-STRATO-PANCREATOGRAPHY. By N. MACARINI AND L. OLIVA. A volume of 218 pages, with 79 illustrations. Published by Edizioni Minerva Medica, Torino, 1955.

Under the above title, the authors consolidate their previous work on the visualization of the pancreas by means of retroperitoneal insufflation, gastric insufflation, and stratigraphy. The first part of this excellent monograph describes the anatomy of the organ, its embryology, physiology, and clinical examination. The second part reviews the various x-ray procedures which have been recommended for study of the pancreas and points out the obvious disadvantages and the occasional advantages of each procedure. The third part deals with the direct visualization of the normal and pathologic pancreas by means of gas contrast anterior and posterior to it and the employment of sagittal and axial stratigraphy. This last procedure represents the first successful attempt toward a direct x-ray study of the pancreas. The published stratigrams, however, show poor detail, and it is rather questionable that small pancreatic tumors can be detected by this technic.

STRATIGRAFIA SELLETIVA E STRATIGRAFIA IN RILIEVO. By ALESSANDRO VALLEBONA, Istituto di Radiologia dell'Università di Genova, with the collaboration of GIOVANNI GARDELLA, ROBERTO GHISLANZONI, NEOPOLO MACARINI, LUIGI OLIVA, ALBERTO PASSERI, ALESSANDRO PIAZZA, GUIDO REGGIANI, ARISTIDE ROLLANDI, and GIOVANNI SANQUIRICO. A volume of 110 pages. Published by Informatore Medico, Genova, 1955.

The author and his associates report in this monograph their investigations of the possibilities of stratigraphy obtained with a single exposure, using multiple films spaced in parallel planes. They employed five to nine films, placing them in a light-proof frame parallel to each other and spaced 0.5 to 1.0 cm. apart without screens. This frame is used instead of the cassette, and the stratigraph is centered on the area of interest. After developing and drying, the films are replaced in the frame and viewed in front of a strong illuminator. This method allows the study of a thick layer of tissue with good definition and gives a good stereoscopic representation. The advantages of the method in the study of large pulmonary lesions are considered.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Cardiovascular System

The Digestive System

RADIOTHERAPY

RADIOISOTOPES

RADIATION EFFECTS

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

The Importance of the Deep Cerebral Veins in Cerebral Angiography, with Special Emphasis on the Orientation of the Foramen of Monro through the Visualization of the "Venous Angle" of the Brain. Paul M. Lin, John F. Mokrohisky, Herbert M. Stauffer, and Michael Scott. J. Neurosurg. **12**: 256–277, May 1955.

The anatomy of the deep cerebral veins is reviewed, with a discussion of their importance in the diagnosis of deep-seated cerebral lesions and possibly in infratentorial lesions, where cerebral angiography in the arterial phase is deficient because sizable branches of the arterial system do not penetrate to the deeper structures. The internal cerebral vein, with its branches, has a relatively constant anatomical position. It is, however, readily compressed toward or stretched away from its fixed dorsal attachment, producing the so-called "displacement syndrome of the venous angle." The "venous angle," which is formed by the internal cerebral and striothalamic veins, serves to localize the posterior border of the foramen of Monro.

In 75.5 per cent of a series of 200 cerebral angiographic studies, satisfactory visualization of the internal cerebral vein and the venous angle of the brain was obtained following a single injection of 10 c.c. of 30 per cent Urokon sodium; in 10.5 per cent there was no visualization of the venous phase, and in 13 per cent the superficial cortical veins were demonstrated without satisfactory visualization of the deep cerebral veins.

On the basis of this material, an attempt was made to establish an orientation chart for the foramen of Monro through the visualization of the "venous angle," using the principles employed in construction of the Vastine-Kinney chart for the position of the pineal body. In 77 "normal" cerebral phlebograms the normal deviation in position of the angle was found to be 6 mm. in any direction. In the presence of a proved intracranial space-occupying lesion the angle was displaced in 23 of 26 selected cases. These cases included frontal lobe tumors, internal hydrocephalus, parasagittal tumors, parieto-occipital tumors, and basal tumors. The change in position of the venous angle in this group indicates that the foramen of Monro can be displaced by any sizable space-occupying lesion.

While the orientation chart constructed by the authors provides a useful basis for study of the position of the foramen of Monro, they point out that, with experience, study of the phlebogram and evaluation of the relationship of the internal cerebral vein and its tributaries to the landmarks in the skull may be of greater diagnostic value than any absolute measurement.

Twelve roentgenograms; 8 charts; 1 photograph; 1 diagram; 1 table.

GRACE LINDSAY, M.D.
Cleveland City Hospital

Angiography in the Management of Intra- and Supra-Sellar Tumours. R. A. Money and G. K. Vanderfield. J. Neurosurg. **12**: 203–215, May 1955.

The authors report their experience with carotid angiography in the diagnosis and postoperative evaluation of 21 cases of intrasellar and suprasellar lesions.

If a tumor in the region of the sella turcica was suggested by assessment of the neurological status, bilateral carotid angiography was carried out. Papaverine, 130 mg., was given just prior to the procedure to reduce arterial spasm. Each common carotid was cannulated percutaneously in turn, 10 c.c. of 35 per cent Diodrast was injected, and anteroposterior and lateral series of angiograms were taken. The procedure was carried out under local anesthesia, or under a basal dose of Avertin if the patient was uncooperative. Pneumoencephalography was done only in those cases where satisfactory filling of the anterior cerebral arteries was not obtained.

The angiograms were of value in demonstrating (1) displacement of major blood vessels, (2) pathological circulation, (3) aneurysms, (4) presence or absence of tumors, (5) large extrasellar extensions of pituitary tumors, and (6) the source of postoperative complications.

Fifteen roentgenograms; 1 table.

GRACE LINDSAY, M.D.
Cleveland City Hospital

Cerebral Angiography by an Intravascular Intubation Technique. Rudolph Jaeger and William H. Whiteley. Am. J. Roentgenol. **73**: 735–747, May 1955.

The authors describe in detail their technic of cerebral angiography by intravascular intubation. The medium is introduced through a polyethylene tube threaded through a needle which has been passed into the vessel percutaneously. The method is applicable to visualization of the common carotid and vertebral arteries, the cerebral veins, the dural sinuses, the jugular vein, and even other vessels of the body.

Since the outstanding difference between this and other technics consists in the use of the polyethylene catheter, most of the advantages of the procedure are attributed to this feature. These are as follows:

(1) Accidental, extravascular injection is obviated.

(2) Mechanical damage to the intimal lining of the vessel is prevented, reducing complications due to embolic phenomena.

(3) Precise, isolated injection of the internal carotid artery is facilitated without actual puncture of that vessel. This reduces the total amount of contrast medium required.

(4) The flexibility of the system eliminates the nervous strain and tension caused by trying to maintain a sharp needle immobile within the artery.

(5) Maneuverability of the patient is assured for proper positioning without dislodging a needle in a precarious location.

(6) A more leisurely, accurate study is possible since the catheter may be kept in the artery "relatively indefinitely."

Nine roentgenograms; 2 photographs.

THEODORE E. KEATS, M.D.
University of California, S. F.

A Note on the Use of 25 Per Cent Iodopyracet (Diodrast) in Cerebral Angiography. D. L. Sutherland, William C. Kite, Jr., J. F. Roach, and Eldridge Campbell. J. Neurosurg. **12**: 223–225, May 1955.

In a search for a safer material that would afford satisfactory contrast in carotid angiography, 25 per cent iodopyracet (Diodrast) was used for 108 angiograms in 87 patients. This solution is more nearly isotonic than the usual 35 per cent solution, although the iodine content is definitely reduced. An evaluation of the technical adequacy of the medium was made

by comparing the films in 25 cases with an equal number obtained with the 35 per cent preparation.

The reduction of the strength of the Diodrast solution was found to affect its value as a contrast medium but little, while a significant reduction in the number of complications was noted.

GRACE LINDSAY, M.D
Cleveland City Hospital

Arteriographic Anatomy of the Anterior Choroidal Artery. Aldo Morello and Irving S. Cooper. Am. J. Roentgenol. **73:** 748–751, May 1955.

The authors describe the arteriographic anatomy of the anterior choroidal artery on the basis of a study of 100 normal lateral arteriograms. The introduction of surgical occlusion of the anterior choroidal artery as an operative approach to the therapy of hyperkinetic disease has resulted in the necessity of more detailed knowledge of the surgical anatomy of this vessel.

The anterior choroidal artery was visualized in 92 per cent of the films examined. Its course was found to be variable, at least four different types being observed. The vessel usually arose in the posterior aspect of the supraclinoid portion of the internal carotid artery, about 2 mm. above the origin of the posterior communicating artery and about 5 cm. below the bifurcation of the internal carotid artery.

The authors emphasize the importance of arteriographic studies before and after surgical occlusion of the artery.

Nine roentgenograms; 1 diagrammatic sketch.

THEODORE E. KEATS, M.D.
University of California, S. F.

Roentgen Diagnosis of Intracerebral Metastases. W. Schiefer, FJ. Rausch, and G. Udvarhelyi. Fortschr. a. d. Geb. d. Röntgenstrahlen **82:** 656–667, May 1955. (In German)

In 130 cases of metastatic processes within the brain reviewed by the authors, the cerebral symptoms were the first manifestation of any disease in about 75 per cent. It is felt that, if metastases are suspected and the primary location is unknown, the patient should be subjected to a thorough roentgen examination. The first step should be a chest film, which may reveal bronchogenic carcinoma or lung metastases secondary to a hypernephroma. An intravenous pyelogram should next be obtained. These two examinations will reveal a high proportion of primary lesions. The third step should be a careful gastrointestinal study. In those cases in which the primary tumor was diagnosed first (for the most part cancers of the colon or breast), the interval before the appearance of cerebral symptoms ranged from ten months to two years.

Forty-two of the authors' series were examined radiologically. In 59.5 per cent the metastases were due to bronchogenic carcinoma, in 9.5 per cent to breast carcinoma, in 9.5 per cent to hypernephroma, in 4.8 per cent to carcinoma of the colon, and in 2.5 per cent to sarcoma. In 7.1 per cent the primary tumor was unknown but other metastases were present, and in an equal number the primary tumor was unknown and there were no other metastases. In 12 instances, the bronchial carcinoma was apparent on the chest films.

The plain x-ray examination of the skull did not give information regarding the site of the metastatic process. A pneumoencephalogram permitted the localization of a solitary lesion, but threw no light upon its character. Most information was obtained by angiography, particularly serial angiography. This latter procedure is much to be preferred, since the diagnosis is frequently missed on a single, simple arteriogram. In 40 per cent of the 42 patients in whom serial arteriography was performed, the tumor was demonstrated and a specific tumor circulation could be recognized. "Staining" of the tumor area with radiopaque material was seen chiefly in the capillary or the venous phase. Only seldom could the tumor be recognized in the arterial phase.

Tumors were found in practically every section of the brain. They ranged in size up to 1.5 or 2.0 cm., and were well defined. Failure of the anterior cerebral artery to show displacement and a more or less normal course of the other vessels was suggestive of multiple metastases. A unilateral displacement of the vessels does not, however, necessarily indicate a solitary tumor.

The differential diagnosis between metastatic carcinoma and meningiomas and glioblastomas was based mainly on the multiplicity of the lesions, their size, outline, etc., rather than the angiographic appearance.

Eleven roentgenograms; 4 tables.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Malignant Round-Cell Neoplasm of Cerebellum Simulating an Angle Tumor with Petrous Ridge Erosion. John M. Meredith. J. Neurosurg. **12:** 311–316, May 1955.

The author reports a case of malignant undifferentiated round-cell tumor of the cerebellum in a man aged thirty-three years presenting a typical cerebellopontine angle tumor syndrome with unilateral fifth, seventh, and eighth cranial nerve involvement and ataxia on the same side.

The case is considered unusual because of the patient's age and the roentgenographic evidence of erosion of the petrous ridge on the side of the tumor, such as is sometimes seen with an acoustic neurinoma. The production of an "acoustic neurinoma syndrome" by a malignant round-cell tumor, without gross invasion of any of the nerves in the lateral angle as demonstrated at the time of surgery, is believed to be recorded for the first time.

Two photomicrographs.

GRACE LINDSAY, M.D.
Cleveland City Hospital

Familial Incidence of Craniosynostosis. Report of Two Cases Occurring in One Family. Lyle A. French and Ralph L. Suechting. Am. J. Dis. Child. **89:** 486–488, April 1955.

Craniosynostosis, or premature closure of the cranial sutures, is a relatively uncommon anomaly. It has been felt by some that it is due to an inherent defect in the germ plasm, and there is no doubt that at least in certain instances the condition is familial and that it may be associated with other congenital defects. It has been reported to occur in siblings and even in successive generations.

The authors present 2 cases, in a brother and sister, to emphasize this family tendency. In the boy craniectomy was performed at eleven months of age and again about two years later, but the patient is obviously mentally retarded. Although the girl had no symptoms referable to craniosynostosis, the mother insisted on skull roentgenograms being taken at birth and at six weeks of age. These revealed progressive closure of

both coronal and sagittal sutures and closure of both anterior and posterior fontanelles. Treatment was instituted immediately. At six years of age the child showed normal physical and mental development.

Two roentgenograms.

Osteoid Osteoma of the Mandible. Report of a Case. Edward L. Foss, Malcolm B. Dockerty, and C. Allen Good. Cancer **8**: 592–594, May–June 1955.

A case of osteoid osteoma of the mandible in a 26-year-old woman is reported. The roentgenological appearance of the tumor and the clinical manifestations were so characteristic that the correct diagnosis was made preoperatively. The rarity of this site of involvement is attested by the fact that no authenticated case of osteoid osteoma of the mandible was found in the literature and no other case has been seen at the Mayo Clinic.

One roentgenogram; 2 photomicrographs.

THE CHEST

Roentgen Manifestations of Pulmonary Tension Disorders in Infants and Children. John A. Campbell. Am. J. Surg. **89**: 1009–1018, May 1955.

The pulmonary tension disorders of infants and children are those characterized by excessive inflation of the bronchial structures, the lung parenchyma, or the pleural space by encysted or trapped air under pressure. The chief causes are check-valve mechanisms derived from (1) developmental bronchopulmonary malformations, (2) bronchogenic pulmonary suppuration, (3) intrabronchial and extrabronchial occlusions, and (4) pleuropulmonary perforations.

Serial chest roentgenologic studies provide the best means of detecting these lesions and evaluating the proper course of management. Although accurate etiologic differentiation is frequently impossible, roentgenographically, because of the similarity of the findings, the manifestations in many instances will be sufficiently decisive to permit identification of the process. Careful correlation of the roentgen appearance of the lesion and its anatomic extent with factors of infection, collateral disease, and age, coupled with an awareness of the pathologic possibilities, greatly improves the specificity of diagnosis.

The roentgenologic findings for the different types of tension disorders are given in detail.

Fourteen roentgenograms. G. M. RILEY, M.D.
Shreveport, La.

Intralobar Bronchopulmonary Sequestration. André J. Bruwer. Am. J. Surg. **89**: 1035–1041, May 1955.

"Intralobar bronchopulmonary sequestration" is the designation applied to the association of a congenital cystic lesion in the lung, almost always found in the posterior basal segment of a lower lobe, with an artery of supply arising from the lower thoracic or upper abdominal aorta. This anomalous artery is due to persistence of connections between the pulmonary plexus and the dorsal aorta, *via* the splanchnic plexus. Damage to the artery in the course of lobectomy may result in massive—even fatal—hemorrhage.

Although intralobar bronchopulmonary sequestration is sometimes discovered on routine roentgenograms obtained during surveys or annual check-ups, most patients come to operation because of repeated acute pulmonary episodes associated with intermittent cough, occasional blood-streaked sputum, fever, chills, and roentgenographic evidence of a pathologic process in one or the other lower pulmonary fields.

The roentgenologic findings are, in most instances, strikingly similar. If the sequestrated segment has no communication with the bronchial tree, the cyst is filled with mucoid material. On a postero-anterior roentgenogram such a cyst (if sufficiently large) is seen as a fairly well defined, solid mass; in the lateral view it is less clearly delineated, with a misty outline. If communication with the bronchial tree exists, one or more air-fluid levels may be apparent. It is pointed out that, although the roentgen appearance is not of itself diagnostic, discovery of a lesion in the characteristic location, in a young person who is either symptomless or presents a history of repeated attacks of pneumonia, makes bronchopulmonary sequestration an outstanding diagnostic possibility.

Four case histories are included; fourteen roentgenograms. G. M. RILEY, M.D.
Shreveport, La.

Roentgen Signs of Primary Staphylococcic Pneumonia in Infancy and Early Childhood. L. Binder. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 585–590, May 1955. (In German)

Primary staphylococcic pneumonia in infancy and early childhood has assumed greater significance in recent years because the *Staphylococcus aureus* has become a more frequent causative agent and because antibiotics are becoming less effective against this organism. While the etiology can of course be established bacteriologically, the laboratory examinations are time-consuming, and readily available x-ray diagnosis is of great advantage.

The route of infection in this type of pneumonia is *via* the upper air passages, through the bronchi, toward the periphery, with rapid involvement of the pleura and the formation of an empyema. The disease process also penetrates the smaller bronchi, enters the peribronchial parenchyma of the lungs, and causes a purulent liquefaction. Small abscesses breaking through into the bronchi may become confluent and, as they communicate with the intrabronchial air, may form fairly large cavities, usually near the periphery of the lungs. These cavities may subsequently break through the pleura, causing a pneumothorax (mostly localized).

The author has observed 31 proved cases of staphylococcic pneumonia. In 26, diagnostic x-ray films were available. Four characteristic roentgen signs were found: (1) a pneumonic infiltrate, (2) an effusion within the pleura (empyema), (3) the formation of one or more small, sometimes confluent cavities within the infiltrate, and (4) very often a localized pneumothorax. These four signs do not, as a rule, occur simultaneously, but may follow in the sequence in which they are mentioned.

Since children under antibiotic treatment frequently show little clinical change in the course of the disease, the x-ray film is the most important indicator of what is going on within the chest. Sometimes a localized pneumothorax is connected with the bronchial system through a valve-like opening. In this event the recognition of a constantly increasing pneumothorax by means of serial films may play a life-saving role, prompting the surgeon to institute suction drainage. The prognosis is surprisingly favorable in spite of the serious radiologic appearance. The cavities may be separated

by thin septa, leading to an erroneous diagnosis of lung cysts.

Six roentgenograms. WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Diagnosis of Intrathoracic Meningocele. Heino Laitinen and Martti Turunen. Dis. of Chest **27**: 547–552, May 1955.

Of something more than 20 proved cases of intrathoracic meningocele recorded in the literature, not more than 4 were diagnosed with certainty without thoracotomy. The author adds another from the First Surgical University Clinic, Helsinki, Finland. In this case the diagnosis was suggested by the presence of von Recklinghausen's disease, a rounded well circumscribed homogeneous tumor in the posterior mediastinum, and characteristic skeletal changes, and was confirmed by air myelography. The most characteristic skeletal change was a thoracic kyphoscoliosis at the level of the tumor. Semilunar erosions in the posterior and left lateral aspects of the sixth to ninth vertebrae were particularly interesting; their shape resembled the scalloping produced by an aneurysm in the anterior vertebral aspect. The pedicles on the left side of the vertebrae were almost completely destroyed and those on the right showed some erosion. On the left side, therefore, the intervertebral foramina formed one large opening. The spinous processes and the related neural arch turned backward and toward the right. The spinal canal was greatly distended at this point. On myelography, air passed readily into the meningocele, where its presence was easily recognizable in the roentgenogram. It was also possible to watch the passage of air from the meningocele into the subarachnoid space and back by altering the patient's position. Excision of the tumor was carried out, and recovery was uneventful.

Seven roentgenograms; 2 photographs.

Detection of Cancer of the Lung. Results of a Chest X-Ray Survey in Los Angeles. Lewis W. Guiss. California Med. **82**: 385–387, May 1955.

In a mass survey for detection of tuberculosis and other chest disease in Los Angeles County in 1950 (see Absts. in Radiology **64**: 610, 613, 1955), a total of 1,867,201 minifilms were taken. Of 5,646 confirmatory roentgenograms obtained for "other chest disease," 3,500 were deemed as possibly representing chest tumor. Of the 3,500 suspicious lesions, 339 were confirmed as chest neoplasms and 260 were classified as malignant. A total of 113 patients were operated upon, with a surgical mortality of 7.1 per cent. In only 70 cases was resection performed with hope of cure, and a three-year cure rate of 35.8 per cent was obtained.

A study of the record of deaths from bronchogenic carcinoma in Los Angeles County in the year of the survey revealed that 27 persons whose films were reported negative in the survey died of the disease. This indicates to the author that less than 10 per cent of persons, even those harboring early bronchogenic carcinoma, will be missed by such a survey.

Six tables. G. W. REIMER
Palo Alto, Calif.

The Masked Bronchopleural Fistula. Bruce J. Franz and James D. Murphy. J. Thoracic Surg. **29**: 512–517, May 1955.

The symptoms and signs of post-resection bronchopleural fistulas are usually definite and unequivocal. Occasionally their presence is unsuspected until a catastrophe supervenes. The authors have selected the term "masked fistula" to describe lesions which furnish unquestionable evidence of their presence only after a period in which the patient seems to be progressing satisfactorily.

Of a series of 625 pulmonary resections between Oct. 1, 1945, and Sept. 1, 1953, 24 or 3.83 per cent were followed by development of a masked fistula. The subjective symptoms and objective signs of the condition are discussed and 4 case histories are given.

Visualization on plain roentgenograms of unabsorbed or increased amounts of intrapleural air, or of an air pocket in a new location, is indicative of fistula formation. The fistulous communication may also be demonstrated by retrograde filling following injection of a radiologic medium into a chest wall sinus. Bronchographic examination is likely to be unsatisfactory, probably due to the high surface tension of the media employed and consequent failure to fill small fistulas.

It is suggested that any patent pleurocutaneous sinus or residual pleural space following any form of pulmonary resection be considered as possible evidence of a bronchopulmonary fistula and every effort be made to prove the existence of this complication.

One figure; 2 tables. A. I. BALMER, M.D.
St. Paul, Minn.

Surgical Implications of the Mediastinal Shadow in Thoracic Roentgenograms of Infants and Children. F. Henry Ellis, Jr., John W. Kirklin, John R. Hodgson, Lewis B. Woolner, and James W. Dushane. Surg., Gynec. & Obst. **100**: 532–542, May 1955.

The authors introduce their paper on the mediastinal shadow in thoracic roentgenograms by a consideration of the normal roentgen appearance. The variability of the mediastinal shadow as seen on thoracic roentgenograms of infants and young children may present a serious diagnostic problem to the surgeon. The shadow cast by the thymus contributes to this difficulty in children under two years of age. It may be unilateral or bilateral and may overlie the cardiac silhouette. When a mediastinal shadow projects into the right thoracic cavity, forming a notch between it and the cardiac shadow, its thymic nature is almost assured. Over the age of two years the thymic shadow is seldom of significance.

The authors reviewed films and records of 98 infants and young children with roentgen findings suggestive of mediastinal cyst or neoplasm. A primary mediastinal tumor was present in 45 cases. Sixty-two per cent of the patients in this group were found to have teratomatous or neurogenic tumors. In 13 per cent the suspicious shadows were due to enterogenous cysts, and in 18 per cent to cystic hygromas and vascular tumors. Nine of the tumors were malignant.

Teratomatous tumors and neurogenic tumors are of equal incidence in infants and children; in adults neurogenic tumors are more common. Of the neurogenic tumors in the younger age group, ganglioneuromas are encountered most frequently. Enterogenous cysts appear to be as common in children as in adults. They may be related to the bronchial tree, esophagus, or gastrointestinal canal, but are most frequently bronchogenic. Cystic hygroma and vascular tumors are found oftener in infants and children than in adults.

Teratomatous tumors characteristically appear on the roentgenogram as fairly dense masses in the anterior

mediastinum, occasionally containing scattered amorphous masses of calcium. They are sharply defined, more commonly located on the right (in the group under review), and may assume large proportions.

Neurogenic tumors tend to lie in the posterior gutter. Neurofibromas are rounded, whereas ganglioneuromas are typically elongated. Either may produce associated bony erosions or deformities. They rarely show visible calcifications. Neuroblastomas, on the other hand, may contain multiple calcified areas.

Enterogenous cysts are dense, sharply circumscribed, uniformly oval lesions generally found in the midmediastinum. They are usually small.

A cystic hygroma appears as a rather large mass, either unilateral or bilateral, in the superior mediastinum; as a rule, it extends into the neck. The margin is sharp, tends to be rather straight, and is directed upward and outward from the hilus to the lung apex.

Vascular tumors lie anywhere in the mediastinum, and usually present a rounded shadow of moderate density without calcifications.

The relatively high incidence of malignant lesions (20 per cent) justifies surgical exploration in instances when the chest film suggests a mediastinal tumor and a diagnosis cannot otherwise be made.

Eighteen roentgenograms; 3 photographs; 2 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Tumors of the Mediastinum and Transverse Tomography. G. Roche and J. Parent. J. franç. de méd. et chir. thorac. **9**: 369–387, 1955. (In French)

The authors consider transverse tomography of definite value in the study of mediastinal tumors, especially in the retrosternal and pretracheal regions. By this means the delineation of abnormal masses and their relations to the mediastinal structures may be clarified. The induction of pneumomediastinum may further aid accurate delineation. It has been noted that benign tumors produce deviation of the trachea, while malignant tumors may cause both deviation and deformity.

The conditions discussed include, among others, aneurysm of the descending aorta, neurogenic tumors, bronchogenic cysts, mediastinal carcinomas, bronchopulmonary cancers, dermoid cysts and teratomas, Hodgkin's disease, thymoma, and goiter.

Fifteen roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

The Problem of Mediastinal Tuberculosis. Harold A. Lyons and Clifford F. Storey. Am. Rev. Tuberc. **71**: 635–667, May 1955.

Mediastinal tuberculosis is of fairly frequent occurrence, though often unrecognized. Its secondary clinical manifestations may obscure the primary cause and direct the clinician's thoughts to some other condition. Mediastinal tuberculosis, either through its active granulomatous reaction or by its healing proliferative process, may involve the tracheobronchial tree, esophagus, or the mediastinal vascular structures. The involvement may produce numerous types of parenchymal infection, superior vena caval obstruction, or esophageal dysphagia.

Roentgen examination is of paramount diagnostic importance. The customary postero-anterior and lateral views will disclose the presence of atelectasis and will show whether it is lobar or segmental in extent. Emphysema may also be demonstrated. Special technics are required when the middle lobe is involved and for the localization of bronchial obstruction.

Treatment resolves itself into two phases: first, therapeutic endeavors directed at the problem of the tuberculous infection; second, measures for the relief of symptoms arising secondarily as a result of bronchial, vascular, or esophageal obstruction.

Ten case reports are included, illustrating different phases of the disease.

Thirty-five roentgenograms.

THEODORE E. KEATS, M.D.
University of California, S. F.

Anatomic-Radiographic Studies of the Prevertebral Retromediastinal Space. G. Bassani. Ann. radiol. diag. **28**: 173–182, 1955. (In Italian)

The author presents 3 cases with radiologic demonstration of the prevertebral retromediastinal space, located on the anterior and lateral aspect of the thoracic bodies, and extending laterally and anteriorly along the intercostal spaces. Right and left non-communicating compartments are identified, the medial boundary being constituted by the anterior longitudinal mid-line of the vertebral column. The right prevertebral space reaches the posterior wall of the azygos vein, which forms its anterior boundary. There is no communication between the prevertebral retromediastinal space (on either side) and the posterior mediastinum or the pleural cavity.

The following anatomical considerations clarify the behavior of some pathological processes: Abscesses originating from the vertebrae invade the prevertebral retromediastinal space and extend into an intercostal space, remaining outside of the prevertebral fascia. Similarly, hematomas which follow fracture of a thoracic vertebra remain in this space if the prevertebral fascia is intact. (Clinically, these hematomas are strictly retromediastinal.)

Six roentgenograms.

R. G. OLIVETTI, M.D.
Newington, Conn.

THE CARDIOVASCULAR SYSTEM

Angiocardiography and Thoracic Aortography in Congenital Cardiovascular Lesions. John G. McAfee. Am. J. M. Sc. **229**: 549–582, May 1955.

This article is an excellent review of angiocardiography and thoracic aortography in congenital cardiovascular lesions, but it contains too much information to be abstracted satisfactorily, and must be read in its original form to be appreciated.

The technics of angiocardiography and aortography are considered; a discussion of the reactions and risks of angiocardiography, selective angiocardiography, and thoracic aortography are then presented. The angiographic signs of the following specific anomalies are described: tetralogy of Fallot, pentalogy of Fallot, transposition of the great vessels, Taussig-Bing syndrome, tricuspid atresia with hypoplastic right ventricle, coarctation of the aorta, patent ductus arteriosus, atrial septal defect, ventricular septal defect, isolated pulmonic stenosis, the Eisenmenger complex, Ebstein's anomaly, persistent truncus arteriosus, anomalous pulmonary venous return, anomalies of venae cavae, congenital pulmonary arteriovenous fistula, anomalies of cardiac position, single ventricle, aortico-pulmonary sep-

tal defects, unilateral atresia or absence of pulmonary artery, persistent atrio-ventricularis communis, congenital stenosis of mitral and aortic valves, miscellaneous anomalies of the aorta, cardiac arrhythmias associated with congenital lesions, congenital cardiac aneurysm, and endocardial fibroelastosis.

One table.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Hemodynamic and Angiocardiographic Observations in an Adult with Persistent Left Superior Vena Cava Draining into the Coronary Sinus and Interatrial Septal Defect. John B. Johnson, John W. Lawlah, and Leslie E. Hedgepath. Am. Heart J. **49:** 777–788, May 1955.

The authors give the history of a 50-year-old female, under observation for nine years, who was considered clinically to have an atrial septal defect. Over this period there had been gradual increase in cardiac size as well as in the prominence of the pulmonary arteries. Angiocardiographic studies and cardiac catheterization confirmed the presence of an interatrial septal defect and showed also a persistent left superior vena cava draining into the coronary sinus. A short review and illustrations of the embryological development of the great veins is given, to explain the occurrence of the latter anomaly.

McCotter (Anat. Rec. **10:** 371, 1916) and McManus (Canad. M. A. J. **45:** 261, 1941) have tabulated the anomalies in cases of persistent left superior vena cava observed in the cadaver, and the present authors have modified these tables as follows:

1. Persistent left superior vena cava without anomaly of the pulmonary vein.
   - A. Associated with right superior vena cava.
     1. With drainage into coronary sinus.
        - (*a*) With cross anastomosis (innominate vein).
        - (*b*) Without cross anastomosis (innominate vein).
     2. Without drainage into coronary sinus.
        - (*a*) Drainage into right auricle *via* innominate vein and right superior vena cava.
        - (*b*) Drainage into left auricle.
   - B. Without associated right superior vena cava.
2. Persistent left superior vena cava draining the pulmonary veins.
   - A. Drainage of pulmonary and systemic veins into right auricle.
     1. *Via* left innominate vein and right superior vena cava.
     2. *Via* coronary sinus.
   - B. Drainage of pulmonary and systemic veins into left auricle.
   - C. Drainage of pulmonary veins alone into right atrium through coronary sinus *via* short left superior vena cava.

The persistence of a left superior vena cava may be of no significance if it drains only systemic venous blood into the right auricle. If it drains systemic and pulmonary venous blood into the right or left auricle, then it may have considerable clinical importance. If the total pulmonary venous drainage is into the right auricle by way of the left superior vena cava, symptoms may be severe. Section of the persistent vessel and implantation of the proximal end into the left auricle has been suggested (Neptune *et al.*: J. Thoracic Surg. **25:** 623, 1953). In the case reported here surgery was not felt to be indicated.

Seven figures, including 8 roentgenograms; 2 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

The Diagnosis of Mitral Insufficiency. Viking Olov Björk, Sven Roland Kjellberg, Gunnar Malmström, and Ulf Rudhe. Am. Heart J. **49:** 719–723, May 1955.

The authors describe a selective angiocardiographic procedure for the diagnosis of mitral regurgitation by injection of 50 to 70 c.c. of contrast substance through a needle directly into the left atrium. A case is reported with illustrations showing the needle *in situ* during ventricular systole and diastole. This same needle may be threaded with a fine plastic catheter for pressure readings in the left atrium, left ventricle, and aorta.

Severe reactions have attended the employment of the procedure, and the authors do not yet recommend it for routine clinical use. It is their contention, however, that this method will prove the existence of a mitral insufficiency when its presence is suggested by other means, thus avoiding an exploratory cardiotomy.

Two roentgenograms; 1 pressure curve.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Abnormal Arteriovenous Communications: Arteriographic Aspects. R. Cordier, A. Gérard, and G. Trinez. J. de radiol. et d'électrol. **36:** 402–405, 1955. (In French)

The authors used contrast arteriography to study a group of patients with cyanosis of the extremities accompanied by vasomotor difficulties. Twenty cubic centimeters of Diodone was injected into the femoral artery in a period of five seconds, and a series of six films was taken. Opacification of the popliteal artery is normally obtained in three seconds, and of the plantar arteries in six seconds. Venous return begins in ten seconds, reaching the veins of the leg in twelve seconds, and the femoral and internal saphenous veins in seventeen to twenty-two seconds.

In 4 patients, the rate of circulation was found to be accelerated. The first patient was a woman of fifty-four years, with symptoms of edematous infiltration of the toes, nose, and ears. Bilateral femoral arteriograms revealed early venous filling. Cutaneous biopsy led to a diagnosis of lymphoid leukemia. After a month of treatment, the cutaneous signs regressed and arteriograms were normal.

The second and third patients, with cyanosis of the lower extremities, also showed early venous filling on femoral arteriography. The fourth patient presented acrocyanosis of all four extremities. Axillary arteriography revealed opacification of the arteries of the hand in one and a half seconds, and venous filling of the hand, forearm, and arm in three seconds.

It appeared that in these patients the circulation was accelerated by direct arteriovenous communications.

Eight roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

The Clinical Application of Portal Venography in Portal Hypertension. R. A. Kemp Harper. Am. J. Roentgenol. **73:** 755–760, May 1955.

A method of portal venography, useful in the problem of treating portal hypertension by surgical means, is

described. By injection of the contrast medium directly into a suitable mesenteric vein at operation—a technic employed by Moore and Bridenbaugh (Radiology **57**: 685, 1951), Child *et al.* (Ibid, p. 691), and others—the hemorrhage incident to percutaneous portal venography is avoided. The surgeon is afforded indispensable information regarding the state and anatomy of the portal venous system, from which he is able to decide on the most satisfactory approach for relieving the hypertension. No complications were noted in 70 cases.

The advantages of the method are given as follows:

(1) The injection is under visual control.

(2) A suitable vein can be chosen (the percutaneous method can be invalidated by a thrombosed splenic vein).

(3) A decision can be made as to whether the obstruction is intrahepatic or extrahepatic without dissection of the portal vein.

(4) The anatomy of the portal vein is demonstrated, and it can be determined whether it is suitable for portocaval anastomosis.

Eight case reports illustrate the use of the method and the variations in anatomy encountered.

Fourteen roentgenograms.

THEODORE E. KEATS, M.D.
University of California, S. F.

Splenoportal Venography in Infancy and Childhood. A. El-Gholmy, H. Grace, M. Ragab, M. Nabway, Mamdouh Gabr, and Neimat Hashim. J. Pediat. **46**: 506–519, May 1955.

Using the percutaneous intrasplenic technic, the authors obtained 46 splenoportal venograms on 33 children. The method was found to be of practical value in assessing the degree of portal hypertension. The venograms were divided into four grades, each of which implies a different degree of portal pressure:

Grade 1: The portal venogram shows dilatation and tortuosity of the splenic vein, with no filling of either splenic or portal collaterals. This occurs when there is augmented splenoportal circulation due either to an early degree of portal hypertension or to congestive splenomegaly without portal obstruction.

Grade 2: The portal venogram shows filling of splenic collaterals. Short gastric veins were found to fill earlier than the inferior mesenteric vein.

Grade 3: The portal venogram shows filling of portal collaterals, with increased density in the splenic collaterals. All advanced cases of liver cirrhosis unassociated with portal or splenic thrombosis showed changes of this grade. The intensity of filling of collaterals was proportionate to the degree of portal obstruction.

Grade 4: The portal venogram shows arrest of the contrast medium along the portal or splenic vein due to portal thrombosis or to portal and splenic thrombosis, with complete reversal of the portal circulation through collateral veins.

It was felt that splenic venography had fulfilled much that was desired for the clinical diagnosis of many cases of obscure splenomegaly and hematemesis.

Thirteen roentgenograms; 5 tables.

THEODORE E. KEATS, M.D.
University of California, S. F.

Percutaneous Lieno-Portal Venography. I. Bergstrand and C.-A. Ekman. Acta radiol. **43**: 377–392, May 1955.

Percutaneous lienoportal venography is a good method, with but slight risks, for the investigation of known or suspected expansive processes involving the splenic or the portal vein and for the diagnosis of space-occupying lesions of the liver. The procedure can give valuable information also in cases of suspected obstruction in any segment of the portal system, especially regarding the site of such obstruction, thereby facilitating the choice of operation. Finally, the functioning of a portacaval shunt can be determined and the outcome of this operation predicted.

The authors report the results of 31 examinations by this method in 24 patients. On 10 occasions the examination was performed because of portal hypertension with splenomegaly, on 6 for checking the function of a portacaval anastomosis, and on 13 for acquiring information concerning the intrahepatic portal branches in patients in whom a liver tumor had been assumed. In 10 of this last group the spleen was found to be of normal size. The 2 remaining examinations were carried out in order to obtain a conception of the normal roentgen anatomy of the portal vessels.

Laparotomy was performed following 18 out of 31 examinations; the splenic bed was examined and biopsy specimens were taken. At none of these operations, performed one hour to twenty-three days after venography, were any signs of splenic hemorrhage detected. In 1 case the contrast medium was injected into the left pleural cavity, and in another the puncture was too deep and the material entered the abdominal cavity.

In the presence of advanced cirrhosis, the main branches of the portal vein tapered rapidly and ran an irregular, tortuous course. The smaller branches were sparser than usual, and the rate of flow was retarded. In 3 cases the contrast medium was obstructed, partly or completely, at the liver hilus as a result of a mural thrombus within the vessel.

Twenty roentgenograms; 1 diagram.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

A Method for Determining the Patency of Portacaval and Splenorenal Shunts. Jerome Giuseffi and Thomas Largen. Arch. Surg. **70**: 707–714, May 1955.

The authors have used a method of visualizing both portacaval and splenorenal shunts in fifteen dogs. At the time of operative production of the shunts, the site of the anastomosis was marked with one or two silver clips to indicate its location.

A catheter was improvised, consisting of a three-lumen polyethylene tube. Two lumens were connected with two inflatable balloons situated 2 in. apart; the third, used for the injection, was perforated over the interval between the balloons. In the dog, the catheter was inserted into the femoral vein, usually on the right side, but in patients it is anticipated that the saphenous vein would be used. The catheter is passed up the inferior vena cava and, with the guidance of the silver clips, is positioned fluoroscopically so that the proximal or superior balloon is above and the inferior balloon below the level of the anastomosis. The injection of 1 to 2 c.c. of Diodrast into the superior balloon demonstrates its position and simplifies accurate positioning in relation to the clips.

When proper location has been attained, both balloons are inflated with Diodrast solution until the desired portion of the vena cava is "trapped." Between 20 and 35 c.c. of 35 per cent Diodrast is then rapidly injected into the inferior vena cava and a roentgenogram is ob-

tained immediately at the termination of the injection. When the anastomosis is open, the medium spills through it from the inferior vena cava and outlines the tributaries of the portal system.

Where a splenorenal anastomosis is to be visualized, the clips give the approximate level of the junction of the renal vein. The balloons are positioned in similar relationship to the clips, and the retrograde injection diffuses from the vena cava into the renal veins and on the left side outlines the anastomosis with the splenic vein.

Postoperative visualization of portacaval shunts has been carried out without particular difficulty in technic or interpretation. In the group of splenorenal anastomoses it was possible to demonstrate a patent shunt on only one occasion, because of technical difficulties in effecting a functional union in the dog, where the splenic vein is small. The presence of an occlusion of the anastomosis has been substantiated in three instances and in so far as the test of the method is concerned, this seems equally important.

The authors believe that their double balloon method is better than that of Tori and Scott, who used a single balloon to occlude the inferior vena cava above the diaphragm (Am. J. Roentgenol. **70**: 242, 1953. Abst. in Radiology **63**: 290, 1954). Especially for the splenorenal anastomoses, "trapping" appears to be the only satisfactory method.

The temporary venous occlusion has shown no deleterious effect in dogs, even when the proximal balloon has extended above the level of the diaphragm and with inflation for as long as forty-five minutes. No adverse effect upon kidney function was observed with the retrograde injection of the contrast material through the renal veins. Also, no permanent impairment of hepatic function was observed in direct injections near the hepatic veins.

The possibility of rupture of the inferior vena cava as a result of inflation of the balloons to abnormal pressures was considered, but it was found that this would require about 10 to 12 c.c. of fluid, whereas occlusion is readily obtained with half that amount of the Diodrast solution. With balloons of very fine latex material, which is easily distensible, no complications should arise.

The authors feel that this method may be used to "trap" any section of the vena cava. Thus, it appears possible that retrograde injection of pelvic veins may be of value for the delineation of pelvic tumors and other abnormalities. Other possibilities which suggest themselves are venography of the vertebral circulation in the diagnosis of spinal cord vascular anomalies, tumors, or block, and visualization of the venous phase of the renal circulation, particularly for the determination of neoplastic invasion of the renal vein.

Five roentgenograms; 1 photograph; 1 diagram.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Acute Renal Failure Following Angiography, Especially the Risk of Repeated Examination, Revealed by Eight Cases (Two Deaths). Nils Alwall, Sven Johnsson, Axel Tornberg, and Lars Werkö. Acta chir. scandinav. **109**: 11–19, 1955.

The authors present 8 cases (2 fatal) of renal injury developing in connection with angiography. These cases were gathered from three different hospitals between 1950 and 1954 and seem to represent all cases of severe kidney injury of this nature occurring in Sweden during recent years. Although in several cases the damage to the kidney could be explained by repeated injection of the contrast medium at the same investigation, there was no explanation in the remainder. The obvious risks may possibly be diminished by decreasing the dose of the contrast material and by careful investigation of renal function before angiography. For the latter purpose non-protein nitrogen estimation is not enough. Determination of the maximal concentration capacity combined with an Addis quantitative test would seem to supply more reliable information on renal function.

Three charts.

THE DIGESTIVE SYSTEM

Roentgen Studies of Esophageal Transport in Patients with Dysphagia Due to Abnormal Motor Function. Stanley H. Lorber and Harry Shay. Gastroenterology **28**: 697–714, May 1955.

Forty patients with dysphagia were observed with a view to determining the effects of several pharmacologic agents on esophageal transport.

Controlled esophageal transport times were obtained in 10 asymptomatic patients, 17 patients with cardiospasm, and 23 patients with "dysrhythmia" (hiatus hernia, constriction ring, esophagitis, tortuous esophagus, or merely dysphagia with normal endoscopic and roentgenographic findings or delayed emptying due to disorganized motor waves).

The normal emptying time (ten seconds) was insignificantly altered by administration of Urecholine or Dibuline [dibutylcarbonate of ethyl-(2-hydroxyethyl)-dimethylammonium sulfate].

Patients with cardiospasm had a three-minute esophageal retention, averaging more than 85 per cent basally. Urecholine caused spasm in all and vomiting in nearly half of these patients. Dibuline relaxed the Urecholine-induced spasm and produced better esophageal emptying. Nitroglycerin was even more effective in this respect.

Patients with "dysrhythmia" showed a decrease in esophageal emptying time following Urecholine and increased retention following Dibuline administration.

These studies indicate a therapeutic as well as a diagnostic use for Dibuline and Urecholine and strengthen the theory of basically opposite types of neurogenic disorder in cardiospasm and "dysrhythmia."

Fifteen roentgenograms; 5 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Oesophagitis and Peptic Ulcer of the Oesophagus. A. S. Johnstone. Brit. J. Radiol. **28**: 229–240, May 1955.

The author introduces this discussion of esophagitis and peptic ulcer of the esophagus by distinguishing the two types of lesion. They are, however, firmly united by a common etiologic factor, the reflux of acid pepsin, which is closely related to sliding hiatus hernia.

Esophagitis is described as resulting from the erosion by gastric juices of the squamous epithelium of the lower esophagus. Peptic ulcer, on the other hand, usually develops in gastric mucosa which has extended into the lower end of the esophagus and, regardless of its location, resembles a true gastric ulcer. The mechanism of reflux is considered at some length and the etiologic theories of hiatal hernia are reviewed.

Roentgen recognition of esophagitis in its early stages is difficult, but as the disease progresses, cicatrization and stenosis may develop and aid in diagnosis. Spasm, however, may mimic stenosis, and in some instances, the narrowing eventually disappears. Gastric ulcer should be suspected in the presence of a crater. A variable degree of stenosis is found in association with the ulcer. Diagnosis is virtually confirmed if there is a short segment of "apparent" esophagus between the ulcer and the herniated stomach, but final confirmation is dependent upon biopsy.

A characteristic radiologic picture is presented, based on cases of hiatus hernia recorded in the literature, in which the entire lower half of the esophagus was found to be lined by gastric mucosa. A triad of stenosis, followed by a segment wider than the esophagus, and then by a pouch of stomach is considered pathognomonic of a gastric-lined lower esophagus, with esophagitis at the mucosal junction.

The author believes it essential to realize that hiatus hernia is brought about by a physiological rather than an anatomical defect, *i.e.*, reflux. The presence or absence of this mechanism is regarded as the vital diagnostic factor. If reflux is present, there is a 75 per cent chance of esophagitis even without convincing demonstration of hernia. When, in the absence of reflux, a small pouch is found immediately above the hiatus with obvious mucosal folds, one is justified in considering it a cardiac antrum, representing a potential hernia.

It is pointed out that reflux must be demonstrated several times during an examination. The author also observes that a hiatal hernia is frequently seen and later disappears in the course of the same examination. The change may be explained by the weight of a full barium meal dragging the herniated stomach into the abdomen. In view of this it might be well to begin the barium meal study with the patient in the recumbent position.

Thirty-five roentgenograms; 3 drawings.

G. J. WOOLHANDLER, M.D.
Shreveport, La.

A Contribution to the Question of Stabilization of Functional Diverticula of the Esophagus. A. Bogsch. Fortschr. a. d. Geb. d. Röntgenstrahlen **82:** 591–593, May 1955. (In German)

Bársony and Polgár observed, in examination of the esophagus with heavy barium paste, that diverticula-like protrusions can sometimes be seen alternating with contractions. This gives the appearance of a string of pearls or sometimes of a corkscrew. The condition originally was thought to be due to a disturbance in the innervation. It is at first not of an organic nature, since after relaxation of the esophagus it may completely disappear. Schinz and Teschendorf have shown that these so-called functional diverticula may become organic or stabilized, in which case the contrast medium may be retained within them for a longer time.

The author observed the case of a 72-year-old man which supports this view. The patient had been having difficulty in swallowing for about eight to ten years. Roentgen examination revealed areas of contraction and dilatation in the lower esophagus, producing the appearance of a spastic colon with haustrations. The contractions seemed to be constant, since barium remnants were found in the dilated portions of the esophagus twenty-four hours after the examination.

[This interesting condition of the lower esophagus is described in the American literature as "dysrhythmia of the esophagus." It is thought to be due to a disturbance of the coordinated nerve play which produces the swallowing mechanism. See abstract of paper by Lorber and Shay, above.—W. A. M.]

Three roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Roentgenologic Study of the Abdominal Segment of the Esophagus in the Presence of Pneumoperitoneum. Costantino Zaino, Maxwell H. Poppel, and Charles F. Blazik. Am. J. Digest. Dis. **22:** 121–128, May 1955.

A roentgen study of the abdominal segment of the esophagus was undertaken in 50 patients being treated with pneumoperitoneum for active pulmonary tuberculosis. Following the administration of barium and mineral oil (see Radiology **64:** 690, 1955), films were made in upright, prone, and Trendelenburg positions, in full inspiration and expiration, in various stages of filling. The presence of pneumoperitoneum provided unusually good visualization of the esophagogastric junction. Tomography of the opacified esophagus was performed on a number of patients, and about half the series were studied fluoroscopically.

The opacified esophagus passing through the diaphragm was best seen in the right anterior oblique position, usually at 30° of rotation, and in full sustained inspiration. The position of the hiatus was not usually directly demonstrated, but in most instances had to be surmised. It was not necessarily at the point where the esophagus seemed to cross the right crus of the diaphragm, but in full expiration was frequently found to be considerably lower. In fact, the true length of the abdominal portion of the esophagus proved to be about half the apparent length, particularly in full expiration. Considerable variations were found to exist, however, on repeated examinations in the same individual, indicating the effect of alterations in abdominal air pressure as a result of changes in position. The true "film" length of this segment is believed to be best determined in the prone right anterior oblique position and in full inspiration, where direct air pressure is minimal.

No true "pinchcock" action was found at the esophageal hiatus. The apparent pinching action in a full esophagus actually resulted from downward displacement of the inferior esophageal sphincter to the level of the esophageal hiatus or even lower. The hiatus is considered to be "nothing but a hole in the diaphragm for the passage of the esophagus," and to have little to do with esophageal action.

In the lower thoracic esophagus the phrenic ampulla was frequently demonstrated. In the Trendelenburg position the emptying of the ampulla was slowed, and occasionally the overfilled lower esophagus was seen to flatten itself on the dome of the diaphragm.

The esophagus is anchored to the diaphragm by the phrenoesophageal membrane. This structure, however, frequently appeared to be overstretched, allowing considerable excursion of the lower esophagus above or below the diaphragm, depending upon abdominal air pressure, fluctuations due to changes in position of the patient, reshuffling of abdominal organs, respiratory action, and possibly visceral-diaphragmatic-peritoneal adhesions.

One case of sliding hiatal insufficiency and hiatus

hernia and one of paraesophageal insufficiency were encountered in the authors' series.

Fifteen roentgenograms; 3 diagrams; 1 table.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Cardio-Oesophageal Intussusception and Operative Cure. Kenneth W. Starr. M. J. Australia **1**: 683–684, May 7, 1955.

A case of cardio-esophageal intussusception is described. The patient, fifty-two years old at the time of the report, had experienced regurgitation since the termination of her first pregnancy in 1928, and severe epigastric and substernal pain during the previous six months. She had recently lost 14 pounds in weight. Roentgen examination with the patient supine and the head slightly lowered showed a marked reflux of the opaque meal into a wide esophagus, which appeared to be quite atonic, but in neither this position nor in a lateral projection was there any sign of hiatus hernia. The impression gained was that of complete incompetence of the cardio-esophageal sphincter. An unusual ring-like conformation at the cardiac end of the stomach led to a diagnosis of intussusception, which was confirmed at operation.

The condition is considered to be rare, but the symptoms and distinctive barium meal findings should render its recognition easy.

Two roentgenograms; 1 drawing.

A Contribution to the Question of Phlegmonous Gastritis Which Does Not Take an Acute Course. F. Asztalos and I. Horváth. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 581–585, May 1955. (In German)

Phlegmonous gastritis is a non-specific inflammatory condition which for the most part has its origin in the submucous layer of the stomach and may extend over a large area. It involves all the layers except the mucosa, which is usually left intact. While acute phlegmonous gastritis is well described in the literature, references to the chronic type are few.

Chronic phlegmonous gastritis may occur primarily or may be secondary to ulcer or carcinoma. Primary chronic phlegmonous gastritis occurs without apparent cause and usually involves a large section of the stomach, sometimes terminating in linitis plastica. In its secondary form the condition is localized, probably because the scarring around an ulcer acts as a barrier to further progression and, in the case of a carcinoma, the lymph channels, packed with cancer cells, do not permit spreading.

The authors present 2 examples. The first, a case of primary chronic phlegmonous gastritis, occurred in a chemical worker in constant contact with paraphenylendiamin, which may have been an etiologic factor. He complained of epigastric pain and loss of weight. An x-ray examination showed a cuff-like, rigid narrowing in the prepyloric area of the stomach which could not be differentiated from a scirrhous carcinoma. At operation, numerous nodules were found in the omentum. Some of them were removed and showed inflammatory changes, but no carcinoma. The patient was treated with antibiotics, his condition improved, he gained in weight, and the roentgenographic abnormalities gradually disappeared.

The second case ran a febrile course. Roentgen examination revealed rather extensive infiltrative involvement of the pyloric portion of the stomach. Exploratory laparotomy showed a massive tumor at this site and extensive lymph node involvement in the omentum. Some of the nodes were excised and the microscopic examination disclosed marked inflammatory changes and some malignant cells. Antibiotic treatment brought about notable improvement, but after ten months the patient's condition deteriorated and laparotomy showed extensive carcinomatous spread. The authors believe that the carcinoma existed at the time of the first operation, but that the patient's condition was aggravated by a chronic phlegmonous gastritis, which responded to the administration of the antibiotics.

Four roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

"Phantom Pain" Following Gastric Resection. B. Gimes. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 605–609, May 1955. (In German)

It is generally held that peptic ulcer falls within the group of psychosomatic diseases. The pain in these more or less neurotic patients produces a well remembered impression within the cortex of the brain. A successful stomach operation may restore the disturbed corticovisceral equilibrium, but many of the patients are not permanently cured by the operation.

The author carefully examined 400 patients who had undergone resection for peptic ulcer. Some had pain due to various disturbances that could be demonstrated radiologically. In 62 patients, however, with definite pain in the region of the pylorus following resection, no radiological evidence of disease could be found.

The innervation of the stomach and duodenum takes place through the submucous plexus, which is directly connected through an extensive system of nerves with the hepatic and pancreatic plexuses containing sympathetic and parasympathetic nerves. In resecting the stomach and the duodenal bulb, the entire system of incoming nerves must be severed. The author believes that at the ends of the severed nerves amputation neurinomas may very well develop, similar to the neurinoma which is observed following amputation of a limb. Inasmuch as the impression of pain in the cortex is still well remembered by these labile and neurotic patients, the disturbances caused by the neurinoma may produce the same type of pain that was experienced preoperatively.

Two roentgenograms; 1 drawing.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Congenital Duodenal Obstruction. A Clinical, Roentgenological, Surgical and Follow-Up Study in 29 Cases. Sigurd Eek. Am. J. Roentgenol. **73**: 713–734, May 1955.

There are two main types of congenital duodenal obstruction: (1) intrinsic, due to anomalies in the duodenum itself, and (2) extrinsic, occurring as a result of pathological rotation of the intestine or, rarely, of an annular pancreas. A series of 29 cases is presented, including 5 of intrinsic and 24 of extrinsic obstruction.

Vomiting of bile-stained material with secondary dehydration dominated the clinical picture. When the stenosis was permanent, the vomiting was continuous. Periodic attacks of vomiting were associated with malrotation of the intestine and volvulus.

The diagnosis depends on the roentgen examination. The patient usually shows enormous dilatation of the stomach and duodenum oral to the obstruction. The dilated duodenum is not infrequently atonic and larger than the stomach, and the pyloric opening is often wide. When the stenosis is complete and has existed since before birth, no intestinal gas is seen caudal to the obstruction.

It is difficult from examination of the stomach and duodenum alone to decide whether the obstruction is intrinsic or extrinsic. This point will usually be decided by a barium enema. The stenosis is extrinsic when there is a malrotation of the intestine and intrinsic when the position of the colon is normal.

Six patients died without surgical intervention. Among the 23 operated cases, there were 3 postoperative deaths. A fourth death in this group was due to intercurrent illness. The other 19 patients were alive from four months to twenty-three years after operation. All had been re-examined and 18 were found to be perfectly well. One patient was still subject to slight abdominal discomfort.

Twelve roentgenograms; 17 drawings; 10 tables.

THEODORE E. KEATS, M.D.
University of California, S. F.

Prolapse of the Gastric Mucosa into the Duodenum. António E. Mendes Ferreira and J. Caria Mendes. Gaz. méd. portuguesa **8**: 213–223, May–June 1955. (In Portuguese)

Prolapse of the gastric mucosa into the base of the duodenal bulb has been seen with increasing frequency in recent years. Its incidence, based on barium meal statistics, is second only to that of duodenal ulcer. Males are apparently more susceptible than females (ratio 4:1) and the maximum incidence is in the fifth decade. The symptomatology is non-specific and suggests duodenal ulcer, which is often associated.

The histories of 9 patients are briefly reported; in 8 of these surgical confirmation of the diagnosis was obtained; the ninth patient had medical treatment only and had not been followed. The senior author, who is a surgeon, believes that in the presence of roentgen findings of gastric mucosal prolapse with concomitant ulcer symptomatology, especially bleeding, the treatment of choice is a liberal gastrectomy. Improvement followed such treatment in this series.

Ten photographs and photomicrographs; 3 drawings.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

The Localization of Duodenal and Prepyloric Ulcers. A Correlation of Radiologic and Gastroscopic Findings with Specimens Resected at Operation. P. H. Davis, E. S. Finckh, and I. J. Wood. Gastroenterology **28**: 736–744, May 1955.

Roentgenologic and pathologic studies of 50 patients in whom antroduodenectomy had been performed for ulcer were accurately correlated.

An ulcer niche was reported radiographically in only 21 patients, and no multiple ulcers were detected by this method. Pathologically, single ulcers were found in 32 specimens and multiple ulcers in 17. The latter were in the duodenum in 14 specimens, and in 13 of these were of the "kissing" type. Of the 73 ulcers, all but 10 were at or below the pylorus. The ulcer niche was correctly localized roentgenographically in only 14 instances.

Roentgen demonstration of a niche was made in all 5 cases of antral ulcer.

Three roentgenograms; 3 photographs; 2 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Intussusception in Childhood. Radiological Appearances on Plain Radiography. J. H. Middlemiss. Brit. J. Radiol. **28**: 257–263, May 1955.

The author has been for some years an advocate of diagnostic examination of the "acute abdomen" by plain radiography. In this paper he reviews the published opinions of others, which reveal considerable conflict of opinion as to the value of a plain film in intussusception, and presents a study of his own based on 62 cases of the latter condition. In none of these cases was a completely normal gas pattern seen in the survey film. Approximately 75 per cent showed radiological appearances consistent with partial, complete, or complicated mechanical obstruction, and about one-fifth of these could be diagnosed radiologically as "intussusception complicated by obstruction." In the remaining 25 per cent the diagnosis could not be made either by direct visualization of the intussusception or by its effect on the abdominal soft-tissue shadows.

The radiological appearances which may be seen in cases of intussusception are listed as follows: (1) direct visualization of the intussusception; (2) a soft-tissue mass in the right iliac fossa or right flank, with displacement of bowel shadows from that area, without direct visualization of the intussusception; (3) intestinal obstruction; (4) the complications of intestinal obstruction.

The author advocates routine use of anteroposterior supine, postero-anterior upright, and lateral views in the presence of acute abdominal symptoms.

Fourteen roentgenograms.

G. J. WOOLHANDLER, M.D.
Shreveport, La.

Carcinoma of a Meckel's Diverticulum Demonstrated at X-Ray. Eliot E. Foltz and J. E. Kearns. Gastroenterology **28**: 851–855, May 1955.

A Meckel's diverticulum was identified roentgenographically by its retention of barium following a small-intestinal examination. Five months later a mass developed in this area and roentgenograms revealed a narrowing of the ileum at the site of the diverticulum. At operation the latter was found to be surrounded by a carcinoma. This is the eleventh such case reported.

Two roentgenograms; 2 photographs; 1 photomicrograph.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Mesenteric Thrombosis; Early Radiographic Sign, With Report of Case. Jeff Baggett and H. W. Ward. J. Arkansas M. Soc. **51**: 285–287, May 1955.

An early radiographic sign of mesenteric thrombosis, consisting in the soft-tissue shadow of an edematous intestinal wall with a localized gas-containing segment, is described. A case is reported in which operation was undertaken on a diagnosis of appendiceal abscess. The affected segment was discovered and excised; the patient failed rapidly and died on the seventh postoperative day.

A review of earlier roentgenograms revealed a single, gas-containing small intestinal segment with the markedly thickened and edematous wall evident as a

soft-tissue density. Of sufficient magnitude to be clearly visible radiographically, this undoubtedly represented the beginning of the mesenteric thrombosis, with the involved segment visualized by edema and hemorrhage into its walls.

This sign has been previously described (see Cregg and Smith: Radiology **61**: 379, 1953).

Two roentgenograms.

Clinical Pathology of the Papilla of Vater. W. Hess. Schweiz. med. Wchnschr. **85**: 495–496, May 21, 1955. (In German)

This is a review of the present status of roentgen cholangiography. It coincides in part with the author's recent book on operative cholangiography, which has been reviewed previously in RADIOLOGY (**65**: 287, 1955). Beyond this, a special point is made of the importance of diagnosing lesions of the papilla of Vater. Stenosing papillitis, in particular, must be recognized whenever it exists; otherwise cholecystectomy will be doomed to failure. In the author's material, this condition was present in 29 per cent of all cases of cholelithiasis, 59 per cent of all cases of common duct stone, and 50 per cent of all patients with recurrent pancreatitis. The radiographic appearance varies according to the location of the narrowing. This may be partial, total, or interrupted, with or without dilatation of an intervening segment, sometimes resulting in a "hydro-ampulla" or producing a prolapse of the papilla into the duodenum. Occasionally a string sign is present, or there may be dilatation of the common duct, pancreatic duct, or both.

A recent discovery is the existence of primary papillitis, previously interpreted by surgeons as "passed stones," "missed stones," or "lost stones." Its symptoms are identical with those of cholelithiasis and pancreatitis, and may include jaundice. Roentgen diagnosis of this condition is important because the treatment of choice is sphincterotomy without cholecystectomy. The normal function of the gallbladder remains intact after such an operation.

Cholangiography with pressure readings also uncovers hypotonia and hypertonia of the sphincter of Oddi. The former is usually a sequel to inflammation or cholecystectomy, the latter to duodenal ulcer. These conditions are not considered a cause but merely a consequence of disease and are classified by the author as functional changes of the papilla.

Cholangiography can lead also to the diagnosis of benign and malignant tumor. The case of a typhoid carrier who remained positive for years despite antibiotic therapy is cited. Finally an adenomyoma of the papilla was resected and a choledochoduodenostomy was performed. This was followed by complete disappearance of the typhoid bacilli.

Nineteen roentgenograms; 1 photomicrograph.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Cholegraphy. The New Contrast Medium Biligrafin. Heinz Oeser and Walter Frommhold. Acta radiol. **43**: 355–368, May 1955.

Biligrafin is the neutral sodium salt of 3-carboxy-2,4,6-triiodoanilide. In a 20 per cent solution it is practically isotonic with physiologic saline. The toxicity on intravenous administration amounts to only one-tenth that of Biliselectan (Priodax) and Telepaque solutions of the same strength.

The excretion of Biligrafin differs basically from that of other known contrast media. About 90 per cent is excreted *via* the liver into the bile and the feces, and only 10 per cent in the urine. In experiments on dogs, the level of the substance in the bile was about 30 to 100 times higher than the plasma level.

Twenty cubic centimeters of the 40 per cent solution of Biligrafin is considered preferable to 40 c.c. of the 20 per cent solution. In routine examinations, the optimum concentration in the gallbladder is reached in about two hours. The biliary ducts may be differentiated as early as ten minutes after injection, with optimum visualization at forty and ninety minutes. By this means, calculi can be demonstrated in the bile ducts.

It is suggested that Biligrafin may prove useful as a means of estimating liver function. In rabbits renal excretion of the medium was found to be considerably increased in the presence of disturbances of the hepatobiliary system. It would be necessary, however, to take into consideration the results of serum protein electrophoresis, since 80 per cent of the contrast substance is bound to the plasma protein as transport medium. A non-filling of the gallbladder is not necessarily due to a disturbance in the liver-bile system. The possibility of a pathologic composition or disturbance in the formation of the blood proteins must be considered in every case.

Side-effects are minimal with Biligrafin. Inasmuch as the medium lowers the blood pressure, the injection must be given particularly slowly to hypotensive patients and those with labile circulation.

Other advantages of intravenous cholegraphy over the peroral method are the shortening of the time of the examination, which is usually completed within two hours, and the certainty that the proper dose of the contrast medium has been administered and entered the blood stream.

Ten roentgenograms; 10 diagrams.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Improved Rapid Intravenous Cholecystography with a New Compound—Cholografin. J. Gershon-Cohen, S. M. Berger, and V. Kremens. Surg., Gynec. & Obst. **100**: 636–638, May 1955.

This is another preliminary report on the performance of intravenous cholecystography with Cholografin, based on 54 examinations. Three cases revealed faint opacification of the gallbladder, and in 3 there was non-visualization. In the remainder both the common duct and the gallbladder outline were well shown. There were no severe reactions.

The authors found results with Cholografin disappointing in the presence of jaundice; otherwise they seem at least equivalent to those obtained with oral cholecystography. Additional advantages are the visualization of the common duct and the infrequent necessity for repeat examinations.

Twelve roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Intravenous Cholecystography with Cholografin in Infants. Thomas E. Reichelderfer and Joyce Van Hartesveldt. Am. J. Dis. Child. **89**: 591–595, May 1955.

A summary of the results of cholecystography with Cholografin in infants is given. The examination was

performed between feedings, with a dosage calculated at 0.6 c.c. per kilogram. The medium was introduced intravenously over a five-minute period, following a subcutaneous skin test for sensitivity. The exposure time was 0.1 second, with 200 ma, a 40-inch focal film distance, and a Potter-Bucky diaphragm. The kilovoltage range was 54 to 65.

In 8 of 12 infants sufficient concentration of the opaque medium in the gallbladders appeared within thirty minutes to four hours, to produce a diagnostic cholecystogram. In a ninth infant, the gallbladder was demonstrated when a double dose was used. In the tenth child, thirty-nine days old, the examination was considered diagnostically unsatisfactory because of overlying gas shadows. In the 2 remaining cases, in a premature infant and one with an inspissated bile syndrome, visible concentration of the opaque medium was not obtained. In no instance were the extrahepatic ducts seen. All of the infants were under one year of age, and 8 were less than six months. The youngest examined was only two weeks old; the youngest in whom the gallbladder was visualized was one and one-half months old. There was no evidence of renal excretion in any case. The test was unattended by untoward reactions except for hiccoughs in one child.

The authors conclude that Cholografin, given intravenously, is probably the most satisfactory cholecystographic agent available for use in infants.

Four roentgenograms; 2 tables.

JOHN W. WILSON, M.D.
University of Texas, Dallas

Side-Effects of Biligrafin. Georg Theander. Acta radiol. **43:** 369–376, May 1955.

The side-effects associated with 500 examinations using Biligrafin [Cholografin] are presented. In 431 of this series a 20 per cent solution of the usual disodium salt was used; in 69 a 40 per cent preparation of a lithium salt was employed. Early side-effects were seen in 25 instances (5 per cent): biliary colic in 4, profuse vomiting in 3, signs of circulatory collapse in 3, lacrimation in 2, coryza and sneezing in 3, edema of the face in 2, diarrhea in 1, and urticaria in 8. In 1 patient with angina pectoris, in 1 with bronchial asthma, and in 2 with epilepsy, injection of Biligrafin was followed by an acute attack of the respective disease. On some occasions, 2 or more untoward reactions occurred in combination.

Late side-effects were seen on 14 occasions (2.8 per cent), including protracted nausea with vomiting in 10, biliary colic in 2, and diarrhea in 1. One patient displayed a severe complex reaction consisting in headache, hoarseness, vomiting, and diarrhea, with subsequent development of jaundice.

Age and sex had no definite bearing on the frequency of the side-reactions, nor was their incidence increased in patients who had been examined previously with Biligrafin.

None of the 67 examinations performed in the presence of jaundice were accompanied or followed by untoward reactions. It is suggested that jaundice protects the patient from undesirable effects of Biligrafin. No side-reactions were seen in the 69 patients receiving the lithium salt of Biligrafin. Of the 431 examinations with the sodium salt, 25 were attended by early reactions and at least 14 patients experienced late reactions.

Three tables. HOWARD L. STEINBACH, M.D.
University of California, S. F.

Intramural Diverticulosis of the Gall Bladder Shown by Radiography—With a Case Report. David Sutton. Brit. J. Radiol. **28:** 264–265, May 1955.

Intramural diverticulosis of the gallbladder is a common condition, known to pathologists since the seventeenth century. These diverticula, known also as Aschoff-Rokitansky sinuses, are present in about 50 per cent of all clinically diseased gallbladders which are explored. Yet a review of the literature revealed only 12 cases which had been diagnosed radiologically. [In a footnote the author refers to a further case appearing after completion of his paper. To this should be added 2 more examples reported by Ross *et al.* in Radiology **64:** 366, 1955.—Ed.]

In the author's case the sinuses in the gallbladder wall were demonstrated on an intravenous cholecystogram, which revealed no other abnormality. Two months later a repeat film failed to show the diverticula, but when the gallbladder was removed their presence was proved microscopically. The gallbladder was thickened and contained many minute calculi.

In all the reported cases of Aschoff-Rokitansky sinuses in which cholecystectomy was done the gallbladder has been found to be abnormal. Their presence, therefore, would appear to indicate a chronic cholecystitis.

One roentgenogram; 1 photomicrograph; 1 drawing.

G. J. WOOLHANDLER, M.D.
Shreveport, La.

Gas-Containing Gall Stones. Harold Fulton. Gastroenterology **28:** 862–866, May 1955.

Careful radiographic technic used on every patient in whom a non-functioning gallbladder is encountered should reveal the typical stellate radiolucencies of gas in gallstones more frequently. A single case is reported by the author. Various explanations of this phenomenon are cited from previous publications.

Two roentgenograms. RICHARD E. BUENGER, M.D.
Chicago, Ill.

Clinical Manifestations of Pancreatitis. Solomon G. Meyers, John Reid Brown, Rachel Boone, and Hugh Henderson. Gastroenterology **28:** 803–809, May 1955.

Roentgenographic studies of the abdomen of 133 patients with pancreatitis (49 per cent confirmed by operation or autopsy) revealed significant abnormalities in 64 per cent. Positive findings in order of their frequency were: ileus (27); basilar atelectasis (11); calcification of the pancreas (13); pancreatic calculi (2); wide "C" loop of the duodenum (9); displacement of the stomach or colon (11); gallstones (3). A poorly functioning or non-functioning gallbladder was observed in 29 patients.

Five roentgenograms; 3 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

THE SPLEEN

The Relation of Splenic Calcification to Histoplasmosis. J. Schwarz, F. N. Silverman, S. M. Adriano, M. Straub, and S. Levine. New England J. Med. **252:** 887–891, May 26, 1955.

Roentgenographic comparison was made of the relation of histoplasmosis to splenic calcification in three geographic areas: Cincinnati, which is in the endemic area, New York City, and Rotterdam (Nether-

lands). Correlation between the roentgen findings and histologic features in the material from Cincinnati was undertaken.

It was found that calcific lesions in the spleen occur in much greater numbers and with greater frequency in the endemic area of histoplasmosis than in other geographic areas. "Typical" foci were found in 44.1 per cent of spleens of adults in Cincinnati, in only 2 per cent in Rotterdam, and in less than 3 per cent in New York. These foci are described as round, with clear concentric structure; they include those with variations in density either in the center or at the periphery, those showing solid calcification, and clearly laminated deposits. Most typical lesions are multiple, five or more being generally present.

The same agent responsible for the high prevalence of skin sensitivity to histoplasmin and pulmonary calcification is considered responsible for the development of these splenic calcifications.

The demonstration of organisms morphologically consistent with *Histoplasma capsulatum* within the splenic lesions is, even in the absence of positive cultures, regarded as acceptable proof of the causal relation between this fungus and the development of typical calcific foci in the spleen. The conclusion is therefore drawn that histoplasmosis, in a large number of cases, becomes disseminated by the blood stream with metastases to the spleen (and probably other organs), without affecting the excellent prognosis in most cases.

Three roentgenograms; 4 photomicrographs; 2 tables.

FRANK T. MORAN, M.D.
Auburn, N. Y.

THE MUSCULOSKELETAL SYSTEM

Osteoporosis. A. M. Cooke. Lancet **1**: 877–882, April 30; 929–937, May 7, 1955.

The author believes the term osteoporosis should be reserved for the deficiency of bone arising from insufficient matrix formation, in the presence of normal calcification of osteoid tissue. He calls attention particularly to the difference between osteoporosis and osteomalacia. Osteomalacia, literally softening of bones, describes a condition arising from a deficiency of calcium or vitamin D or both; it should not be used as a synonym for osteoporosis in such phrases as senile osteomalacia and postmenopausal osteomalacia. Strictly speaking, osteoporosis is a pathological diagnosis and can be made with certainty only by the histologist, but there are a number of clinical features and x-ray appearances which may justify this diagnosis in the living.

The salient feature of the morbid anatomy is atrophy of bone. The histologic picture is simply that of too little bone: what there is is of normal structure. It may be in the state of undergoing resorption, of being stationary, or of growing by apposition of new matrix and new bone.

The growth of normal bone and its maintenance in health in the adult depend on a number of factors—genetic, nutritional, endocrine, and mechanical. The last three factors the author discusses briefly, with special regard to osteoporosis. The skeleton undergoes slow, steady resorption from all its surfaces, more apparent in cancellous than in compact bone. This process is counteracted by endocrine factors and the physical stresses and strains of use. It is affected to a lesser extent by diet and age. The ratio of women to men with osteoporosis is six to one.

The symptoms of osteoporosis vary from none at all to complete incapacity from severe pains. The pains are of many types, mainly in the back, radiating around the trunk, to the buttocks, and down the legs. They are usually aggravated by movement, jarring, or flexing the trunk. Sometimes the pains are made worse by coughing, sneezing, or straining at stool, suggesting a root origin, but compression of the spinal cord does not occur.

The physical signs likewise vary—from none at all to gross spinal deformity. The commonest finding is a shortening of the trunk giving rise to a rounded kyphosis and a transverse fold of skin across the upper abdomen. The infolded skin is keratinized, showing that the fold is of long standing and not a temporary postural phenomenon.

The x-ray findings in osteoporosis are important. In advanced cases it is difficult to obtain good roentgenograms, because of the poor contrast between the bones and soft tissues. The condition is most marked in the spine, especially in the lumbar vertebrae. There is sometimes poorly defined bone texture—the so-called ground-glass appearance; sometimes a fainter but coarser trabecular pattern. The longitudinal trabeculae are more prominent than the transverse, presumably because the stresses are greater up and down the spine than across. The bodies of the vertebrae are biconcave, with increase in size of the intervertebral disks. The end-plates may be denser than normal. There is a general deformity of the spinal column, with a rounded kyphosis. There may be a wedge-shaped deformity of individual vertebrae. All degrees of collapse occur: sometimes the spinous processes are so close together that false joints develop between them. (Other decalcifying diseases, especially osteomalacia, produce a similar x-ray picture in the spine, and it is unwise to make the diagnosis of osteoporosis on this one observation alone.) It is usually stated that in osteoporosis the pelvis may be slightly affected, the long bones scarcely ever, and the skull almost never; actually, the other bones are affected, but less obviously so. Pathological fractures are three times as common in osteoporosis as in any other non-malignant condition.

The patient with senile or postmenopausal osteoporosis should be made to get out of bed, if only to sit up in a chair, at the earliest possible moment. A high-protein diet and a pint of milk a day will ensure an adequate supply of the materials from which bone is formed. Since an endocrine factor is involved, hormone therapy is indicated. The author has treated 50 patients (43 women, 7 men) at Radcliffe Infirmary, Oxford, over the past sixteen years. Thirty-seven were given hormones; follow-up was adequate in 27 cases. All but 1 of this number reported subjective improvement in varying degrees. Sixteen patients over sixty-five were treated with endocrines, and all but 1 was obviously greatly improved.

Twenty illustrations, including 9 roentgenograms.

Renal and D-Avitaminosis Osteomalacia. E. Uehlinger. Schweiz. med. Wchnschr. **85**: 521–527, May 28, 1955. (In German)

Osteomalacia is caused by calcium deficiency, due either to inadequate calcium intake (resorptive osteomalacia) or to excessive calcium excretion (excretory osteomalacia). The prototype of the former is D-avitaminosis osteomalacia. The latter is represented by renal osteomalacia.

Basing his discussion on 2 cases, the author considers the question of whether the two different pathogeneses cause different or identical skeletal findings.

The first patient was a 71-year-old white female suffering from osteomalacia caused by vitamin D deficiency. A left femoral neck fracture at the age of sixty-four had made walking difficult, confining her to her room. For years she had lived without sunlight, on an inadequate diet without fresh vegetables and low in vitamins. Following the fracture she noticed a progressive kyphosis and shortness of breath. The classical roentgen picture of grave progressive osteomalacia was aggravated by senile osteoporosis. The clinical findings were: skeletal pain, right-angular gibbus of the mid-dorsal spine, bell-shaped thorax, and bulging of the sternum, with indentation of the lateral thoracic walls.

The second patient, a 75-year-old white female, complained of skeletal pain, with limited use of the left hip joint, and hunchback. She suffered also from angina pectoris with myocardial infarction. The roentgen examination revealed an advanced osteomalacia with granular atrophy of the skull bones, compression of some vertebrae, and transformation zones in the pubic rami and left femur. The diagnosis of osteomalacia was confirmed by a pelvic biopsy and by the blood chemistry. After two months of hospitalization the patient died of cardiac insufficiency due to coronary sclerosis with myocardial infarcts.

The skeletal findings in both cases are identical with respect to the localization and severity of the osteomalacia and also the presence of the Milkman syndrome (transformation zones). In both patients there were pronounced fibro-osteoclastic transformation, an osteoporosis of the bones forming the roof of the skull, a kyphosis of the dorsal spine, and a bell-shaped thorax. The transformation zones were prominent in the ribs and pubic rami. The second patient showed also extensive damage of the kidneys, involving wedge-shaped sections of the parenchyma, due to interstitial nephritis, leading to tubular renal insufficiency. There was an associated hyperparathyroidism, with mobilization of the calcium reserve of the skeleton and simultaneous hyperphosphaturia, hypocalcemia, hypophosphatemia, and osteomalacia.

The types of osteomalacia in these 2 cases can be easily established by means of the blood chemistry and urinalysis. In the first patient there was insufficient calcium resorption due to vitamin D deficiency. In the second patient there was increased excretion of calcium by the kidneys. A characteristic triple layering of the vertebral bodies, with marginal sclerosis of the upper and lower plates and osteoporosis of the middle layer, was present in both cases and demonstrated on radiographs and maceration specimens. An associated osteitis fibrosa was also noted in both patients.

The author concludes that the etiologic differentiation should always be established, as it is important for prognosis and treatment.

Fourteen illustrations, including 4 roentgenograms.

HERBERT POLLACK, M.D.
Chicago, Ill.

Primary Hyperparathyroidism. Addison G. Brenizer, Jr. Ann. Surg. **141**: 722–736, May 1955.

Primary hyperparathyroidism, caused by excessive production of parathyroid hormone, diagnosed with finality only in the laboratory, and properly treated solely by surgery, is characterized by the laboratory findings of hypercalcemia, hypophosphatemia, and hypercalcinuria. Rarely recognized in its pure form, it is usually diagnosed by means of its complications, which may involve the skeleton or the urinary tract, separately or in combination.

The differential diagnosis of the condition is outlined and illustrated by appropriate cases. A positive diagnosis is usually not established until symptoms have been present for several years. Most parathyroid tumors are neither visible nor palpable, although a few have been demonstrated radiologically by deformity of the barium-filled esophagus. In recent years, cases with extensive skeletal lesions and the classic radiologic changes are not commonly encountered, because bone disease is prevented or ameliorated by moderate use of milk or dairy products in the diet. Urinary tract stones and nephrocalcinosis appear to be the more common complications of the disease.

Several causes of hypercalcemia, the most constantly observed finding, must be excluded in the differential diagnosis. The chemical findings associated with metastatic lesions in bone, for example, may suggest hyperparathyroidism, but the radiological picture of sharply defined local lesions in generally normal bone should facilitate a correct diagnosis.

Primary hyperparathyroidism with bone disease must also be distinguished radiologically from several skeletal diseases. When recognizable skeletal lesions are present, a positive diagnosis can usually be made from the roentgenograms alone, but the radiologist is unable to distinguish between the pictures produced by primary and secondary hyperparathyroidism; the latter results from phosphate retention and must be diagnosed clinically.

Classically, hyperparathyroidism produces a generalized skeletal decalcification, and there may be scattered localized tumors or cystic lesions. The skull usually exhibits a granular decalcification or ground-glass appearance, with ragged or moth-eaten areas of bone resorption. The lamina dura about the teeth may be lost, and there may be a variety of deformities of chest, spine, and pelvis; pathological fractures may be present. When involved, the phalanges show a characteristic subperiosteal resorption of bone which produces a lace-like pattern seen in no other condition. Two other generalized bone diseases can usually be distinguished by the radiologist: in osteoporosis the skull and lamina dura are not affected and there is no evidence of cysts or tumors. In osteomalacia, also, cysts and tumors are absent, although the generalized skeletal decalcification may obliterate the lamina dura. Rickets, which can be considered a variant of osteomalacia in children, can ordinarily be recognized by its wide, irregular epiphyseal lines.

The author considers that there is no satisfactory treatment for hyperparathyroidism other than surgical removal of the hyperfunctioning tissue. Four cases, treated surgically, are reported.

Fourteen roentgenograms. G. M. RILEY, M.D.
Shreveport, La.

Pseudohypoparathyroidism. Clinical Picture and Relation to Convulsive Seizures. Boy Frame and Sidney Carter. Neurology **5**: 297–310, May 1955.

A clinical review of 25 cases of pseudohypoparathyroidism is presented. Twenty-four cases were collected from the world literature and an additional case is reported in detail. Nineteen of the 25 patients were

females. The usual presenting symptoms are tetany and convulsions due to hypocalcemia. The patients commonly are of short stature, with round faces and mental dullness.

Roentgenographic abnormalities include an increase or decrease in density of the skeleton; in 2 patients both increased and decreased density were observed. The metacarpals are short and in some cases similar changes are seen in the metatarsals. These bones may be quite thick and deformed. In several of the cases the phalanges were also broad and distorted. The long bones may show similar involvement, including widening of the medullary cavities, spur formation on the tibia, bowing of the fibula, coxa valga and vara. The cranial vault may be thickened and granular in character, and the teeth may be shortened, with defective root formation.

Ectopic calcification is common in basal ganglia, muscle, ligaments, tendons, bursae, and subcutaneous tissues. The outstanding laboratory abnormalities are a depressed serum calcium and elevated serum inorganic phosphorus. A poor diuretic response to the intravenous administration of Parathormone is almost pathognomonic of pseudohypoparathyroidism.

Significant symptomatic improvement can be expected to result from proper therapy, including dihydrotachysterol and vitamin D.

One roentgenogram; 1 photograph; 1 electroencephalogram; 1 table. THEODORE E. KEATS, M.D.
University of California, S. F.

Osteitis Deformans or Paget's Disease in Madras. A. N. K. Menon. Indian J. Radiol. **9**: 78–84, May 1955.

Although osteitis deformans is a common disease in western countries, it is apparently quite rare in India. The author describes 2 typical cases from a group of 9 observed over a three-year period in an Indian general hospital. After a discussion of the general clinical and radiographic features, he presents a moderately detailed summary of the cases. The first patient was a man of sixty, with a clinical history of some three years duration. Typical biphasic bone changes occurred in the skull, spine, pelvis, and long bones of the upper arms and legs. The second patient, a man of fifty-nine years, had a six-year history and showed typical radiographic changes in the skull and leg bones.

Eight roentgenograms; 1 photograph.
JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Nature of Certain Osseous Lesions in Tuberous Sclerosis. Willard W. Dickerson. Arch. Neurol. & Psychiat. **73**: 525–529, May 1955.

The author reports in detail a single case of tuberous sclerosis followed for many years and extensively studied at autopsy. He is concerned chiefly with the nature of the osseous lesions demonstrated radiologically in the phalanges of the hands. The patient was an epileptic and had been an inmate of a state institution for ten years, when a roentgen examination revealed cystic dilatations in the tips of the terminal phalanges of all fingers.

Microscopic examination of the sectioned phalanges at autopsy showed a resorptive process of the osteoclastic type. The "cystic" areas observed on the roentgenograms were found to be composed of tightly packed, fully mature collagenous connective tissue, with no features to suggest neurofibromatosis or any form of neoplasm. Actually they were not cysts but areas of non-specific fibrous replacement of bone, encompassed by a proliferative process resulting in an abundant osteoid matrix.

The author believes these lesions are unlike those of any other disease producing fibrous replacement of bone, and that they may be unique to tuberous sclerosis. A differential diagnosis of disease entities producing lesions of somewhat similar histopathological structure is given.

In a general consideration of tuberous sclerosis it is pointed out that at least 50 per cent of the patients will show intracranial calcification in the region of the basal ganglia. A few have calcification in the dentate nuclei of the cerebellum. Periosteal changes of the metatarsals and metacarpals and cyst-like changes in the phalanges of the hands in particular are seen in approximately two-thirds of the cases. The author's patient showed the characteristic plaque-like zones of sclerotic bone in the inner table of the skull overlying cortical nodules in the brain. She also presented wavy, irregular periosteal changes along the shafts of the metacarpals and metatarsals.

Three photomicrographs. J. W. BARBER, M.D.
Cheyenne, Wyo.

Alkaptonuria: Report of 12 Cases. William J. Martin, Laurentius O. Underdahl, Don R. Mathieson, and David G. Pugh. Ann. Int. Med. **42**: 1052–1064, May 1955.

Spontaneous alkaptonuria is a hereditary, familial, and congenital anomaly of the metabolism of the amino acids, tyrosine and phenylalanine. The author reports 12 cases, in 8 of which ochronosis was present.

The term "alkaptonuria" refers to the darkening of the urine on standing or on addition of alkali, due to the presence of "alkapton bodies" (homogentisic acid). The term "ochronosis" refers to the metabolic condition which results in deposition of alkapton bodies in certain tissues. Ochronosis may be apparent from pigmentation of the parts of the body where homogentisic acid is deposited. It may be asymptomatic or it may induce "ochronotic" or "alkaptonuric osteoarthritis," attributable to degeneration of the joint cartilages associated with the foreign material.

The characteristic pigmentation may appear in the eyes, in the cartilage of the ear, in the fibrous tissues and tendons about the knuckles and knees and on the dorsa of the feet. Brown or black pigment may also be distributed on the nose and cheeks, in the shape of a butterfly. The skin of the axilla is particularly likely to become colored by deposits of homogentisic acid, since this acid is excreted by the sudoriferous glands.

The joints most often affected by ochronotic arthritis are those of the spinal column, shoulders, knees, and hips. Clinically, this condition resembles osteoarthritis, but reaction may be so severe that the question of rheumatoid arthritis is raised. Roentgenographically, also, the condition is suggestive of a certain chronic type of osteoarthritis.

Roentgenographic changes in the spinal column are so characteristic as to be almost pathognomonic, consisting in extensive degeneration, flattening, and calcification of the degenerated intervertebral disks. Fusion of the anterior aspects of several of the vertebral bodies in the thoracolumbar region may be seen at times. Calcification of the anterior longitudinal vertebral liga-

ments may mimic rheumatoid spondylitis. When degeneration and calcification of the intervertebral disks are present, calcification of the cartilage of the symphysis pubis is common. In 4 of the authors' cases there was involvement of the shoulder joints: narrowing of joint spaces and hypertrophic changes. Osteochondromatosis or loose bodies in such joints as the knee were observed in 3 cases. Tendinous calcification may occur. In the ears, the helix and the antitragus may contain small calcific deposits.

Four roentgenograms; 2 photographs.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

A Comparison of Bone-Marrow Aspiration and Skeletal Roentgenograms in the Diagnosis of Metastatic Carcinoma. George A. Hyman, with technical assistance of Jane L. Harvey. Cancer **8:** 576–581, May–June 1955.

This study had as its objectives: (1) determination of the frequency with which bone marrow involvement by metastatic carcinoma could be documented by bone-marrow aspiration; (2) a comparison between bone marrow aspirations and skeletal roentgenography in the diagnosis of metastatic bone disease; (3) an evaluation of the procedure as a criterion of operability in patients with presumed "early" carcinoma.

Of 650 aspirations performed, approximately 10 per cent revealed clumps of tumor cells. In 57 per cent of this latter group of patients diagnostic changes were evident on one or more skeletal roentgen surveys; another 6 per cent showed suggestive changes and in 37 per cent there were no abnormalities. On the other hand, of 100 cases of proved carcinoma in which a single marrow aspiration was negative, one-third had demonstrable lesions. These figures indicate how each investigative method complements the other.

In several patients with presumed "early" carcinoma, a marrow aspiration was positive for tumor cells. Bone marrow aspiration appears valuable as a survey technic, therefore, to avoid useless and sometimes mutilating surgery. It should be especially valuable in evaluating "early" carcinomas of the breast, lung, prostate, kidney, and thyroid.

Six photomicrographs; 2 tables.

PAUL W. MATHEWS, JR., M.D.
University of Texas, Dallas

Gargoylism: Two Cases in Siblings. Frank C. Stiles. Wisconsin M. J. **54:** 250–252, May 1955.

Cases of gargoylism are reported in two brothers of four and five years. The older child was admitted to the hospital because of retarded speech and mental development. The face was broad and flat, with a prominent forehead and coarse features. Roentgen examination showed depression of the skull anteriorly in the region of the inion. The sella turcica appeared normal. The metacarpals and phalanges were short and broad with some evidence of triangulation. The bone age of the wrists was three years (the chronological age was five years). A lateral film of the dorsolumbar spine showed deformity of the anterior portion of the second lumbar vertebra. All vertebral bodies appeared somewhat convex. There was widening of the mid-portions of the shafts of both humeri. Periosteal thickening along the lateral aspects of the femoral shafts was obvious. Both radii and ulnae were abnormally curved and bowed laterally.

The findings in the four-year-old child practically duplicated those in his brother.

Two roentgenograms; 2 photographs.

The Clinical and Radiologic Picture of Hemangioma of the Spinal Column, With Report of a Case Involving the Dorsal Spinous Processes in the Upper Cervical Region. Walter Güntert. Radiol. clin. **24:** 167–186, May 1955. (In German)

The radiologic appearance of hemangioma in the vertebrae is characteristic, but not pathognomonic. The same picture is occasionally presented by a lymphogranuloma or metastasis with multiple cystic areas of radiolucency. The typical changes produced by hemangioma are given as follows:

1. Alteration in form of the vertebral bodies: If the lesion is large enough, a "blown-up" vertebra results (*vertèbre soufflée*).

2. Structural changes: The number of vertical trabeculae is diminished, but those remaining are thickened.

3. Involvement of the arch and processes, either by extension or primarily.

The author reports in detail a case involving the spinous processes of the upper cervical vertebrae which presented some unusual clinical and roentgenologic features. The patient, a thirteen-year-old girl, had suffered since early childhood from increasing stiffness of the neck and limitation of movements of the head. A hard, fixed tumor, the size of an egg, was present in the neck. Roentgenograms revealed the spinous processes of C-2, 3, and 4 to be considerably distended, forming a large mass containing many cystic foci, from the size of a millet seed to a hazelnut. The associated vertebral arches were thickened, with a spongy structure. The vertebral bodies initially showed no changes. The diagnosis was made by biopsy. Roentgen irradiation produced some sclerosis but the changes nevertheless progressed. Finally, the vertebral bodies themselves showed signs of tumor infiltration. The clinical symptoms, however, partially regressed.

This case differs from the usual case of vertebral hemangioma with respect to the youth of the patient, absence of neurological symptoms, and limitation of neck and head motion.

Since the spinous process has no weight-bearing function, it is to be regarded more as an extravertebral skeletal element than a functional part of the vertebral body. It is reasoned that the changes induced in the dorsal spinous process as a result of the hemangioma should therefore resemble those in the extravertebral bone. Since the appearance of the hemangiomas occurring in the two parts of the vertebrae are so unlike, different conditions enter into the differential diagnosis. Whereas one should consider lymphogranulomatosis, leukemia, spinal metastasis, tuberculous and syphilitic spondylitis, actinomycosis, and hyperparathyroidism in the differential diagnosis of vertebral body hemangiomas, these possibilities can be disregarded when the spinous process is involved. The conditions which can be confused with hemangioma in the spinous process are giant-cell tumor, osteochondroma, osteosarcoma, anomalies of fusion with rarefaction, and possibly even echinococcosis.

Nine roentgenograms; 1 photomicrograph; 1 drawing.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Eosinophilic Granuloma of Ribs. Review of Literature and Report of Two Cases with Four and Six and One-Half Year Follow-Up, Respectively. James F. O'Neill, Stanley J. Skromak, and Paul R. Casey. J. Thoracic Surg. **29**: 528–540, May 1955.

Eosinophilic granuloma of bone is discussed from the standpoint of its pathologic and clinical features and its relationship to Letterer-Siwe's syndrome and to Hand-Schüller-Christian's syndrome. An excellent table summarizes the findings in the three conditions.

The authors found 187 cases of eosinophilic granuloma of bone reported in the literature, to which they add 2 more, raising the total to 189. Their patients were followed for six and one-half and four years, respectively. Each had a solitary eosinophilic granuloma of a rib and, following resection of the involved bone, remained entirely well.

The x-ray appearance of eosinophilic granuloma is that of a small or large, irregularly destructive, radiolucent zone, with or without periosteal reaction, bone consolidation, or pathologic fracture. In flat bones the lesion is usually circumscribed, sharply delineated, or punched out. In the ribs there may be destruction, with expansion of the cortex, perforation, pathologic fracture, periosteal new bone formation, and thickening of the overlying tissues. The differential diagnosis includes all the neoplastic and inflammatory diseases of bone. The authors conclude that accurate diagnosis can be made only by biopsy.

Surgical treatment should probably be limited to biopsy or treatment of sequelae. X-ray therapy is apparently helpful in relieving pain and may aid in repair. Its use seems indicated until a better method becomes available.

The finding of a single eosinophilic granuloma in one bone should initiate a complete skeletal survey, as well as a careful search for any visceral involvement. In all patients where lesions are limited to the skeleton, healing will probably occur, the outlook improving with increasing age of the patient. In infants and children the prognosis must always be guarded in view of the possible development, months to years later, of Letterer-Siwe's or Hand-Schüller-Christian's syndromes. In adults, the prognosis is better than in children, but there remains the possibility of subsequent recurrences, new lesions, or involvement of lungs or skin.

A comprehensive listing of 106 references to the world literature is appended.

Three roentgenograms; 2 photomicrographs; 2 tables.

A. I. BALMER, M.D.
St. Paul, Minn.

Osteochondral Fracture of the Femoral Condyles. Mark B. Coventry and Alexander J. Walt. Surg., Gynec. & Obst. **100**: 591–594, May 1955.

A blow to either femoral condyle, especially when the knee is partially flexed, may result in the dislodging of a small portion of articular cartilage and subjacent bone. These osteochondral fractures are probably more common than is generally suspected, and may involve either the femur or patella.

The loose fragment can often be identified roentgenographically by means of intercondylar notch views, but the site of origin is seldom found on the film. Surgical removal is the treatment.

The relationship to osteochondritis dissecans is doubtful. In the 3 cases reported in this article, there was no previous history of disturbance of the knee; the history of injury and operative findings were clear cut.

Six roentgenograms; 6 photographs.

DON E. MATTHIESEN, M.D.
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GYNECOLOGY AND OBSTETRICS

Clinical Experiences with Soft-Tissue Placentography. Robert Percival and Stanley Murray. Lancet **1**: 1045–1051, May 20, 1955.

The authors again call attention to the advantages of soft-tissue placentography which, in their experience, has proved a safe and reliable method of establishing the position of the placenta. Two hundred seventy-five cases were studied over the three-year period 1951–53. The technic employed was essentially that described by Reid (Brit. J. Radiol. **22**: 557, 643, 1949. Abst. in Radiology **55**: 462, 1950) and Whitehead (Brit. J. Radiol. **26**: 401, 1953. Abst. in Radiology **62**: 908, 1954), but the number of films taken was reduced to two, an anteroposterior and a standing lateral, including the whole of the uterus and the pelvic inlet. In some patients a third view was needed, the tilted lateral, when the standing lateral showed apparent forward displacement. High kilovoltage (115–120 kv) was used for the lateral views. Development is cut to three and a half minutes to avoid overblackening of the part of the film which shows the anterior wall.

In 50 cases of proved placenta praevia, the correct diagnosis was made in 46 and an erroneous diagnosis in 1. The error was made early in the series and was due entirely to inexperience in interpretation. In the remaining 3 cases the diagnosis was "borderline placenta praevia."

The advantages of placentography are greatest in the conservative management of antepartum hemorrhage. In 84 cases hemorrhage was not ascribed to placenta praevia; a correct diagnosis was made radiologically in 82. In 1 case placenta praevia was erroneously diagnosed and 1 case was borderline.

Placentography proved particularly useful in patients suspected of having placenta praevia before bleeding occurred. In 113 cases with high head, breech, unstable presentation, etc., with no antepartum hemorrhage at the time of examination, the placenta was correctly localized in 109 and incorrectly in 1. The other 3 cases were essentially borderline.

That certain placental positions may cause persistent breech presentation has been confirmed by the authors' observations. No association was found between the placental site and accidental antepartum hemorrhage.

Three tables.

The Roentgenologic Findings in Intrauterine Death. K. Fochem. Radiol. clin. **24**: 162–167, May 1955. (In German)

The author discusses signs of fetal death and some of his experiences with them. He offers the following outline:

A. Fetal skull signs:

1. Overlapping sutures (Spalding's sign). This sign is significant only if it is clearly visualized, the amniotic sac is still intact, and no labor pains are present.

2. Asymmetry of skull, caused by a decrease in tonus and advanced decalcification.

3. Flattening of the cranial arch.
4. Separation of skull bones and increase in skull circumference. This is a late sign.

B. Spine signs:

1. Gibbus deformity. The author feels that this is the most reliable sign next to Spalding's, but it must be pronounced.
2. Marked lordosis or extension.

C. Other signs:

1. Loss of definition of the fetal skull (late).
2. Change of position and persistence of position of the fetus have both been described as signs indicating fetal death. The author feels that neither of these signs alone contributes to the diagnosis, but a change in position of the fetus does not exclude fetal death.
3. Discrepancy between the size of the fetus and duration of pregnancy.

The author emphasizes that only positive findings are of worth in the diagnosis of fetal death and that no single one of these is pathognomonic. Only after the sixth month of pregnancy can the diagnosis be made. Opinions vary as to how soon after death the x-ray signs appear. Spalding's sign may be seen after intervals of several hours to five days. Spinal signs are usually later.

[The author does not mention what is probably the most important sign of all indicating fetal death, namely, the presence of gas in the fetus. See Crick and Sims: J. Fac. Radiologists **5:** 126, 1953. Abst. in Radiology **63:** 779, 1954.—C.V.C.]

Six roentgenograms. CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

THE GENITOURINARY SYSTEM

Translumbar Aortography as a Diagnostic Procedure in Urology, with Notes on Caval Phlebography. N. S. R. Maluf and Cornelia B. McCoy. Am. J. Roentgenol. **73:** 533–573, April 1955.

In the authors' opinion, translumbar aortography, with local procaine anesthesia and 70 per cent Urokon or 75 per cent Neo-Iopax, is a safe procedure. They describe their technic in detail. In 250 cases the most serious complication encountered was division of the thoracic lymph duct. This was due to lack of familiarity with the technic and could have been avoided if due care had been taken. The water-soluble organic iodides are not detrimental to renal function even when the latter is markedly reduced by chronic disease. Injection of 80 per cent sodium iodide directly into the renal artery in 1 case did not damage the kidney. The intra-aortic injection of 75 per cent Neo-Iopax produces a prompt but fleeting fall in arterial pressure, followed by a rapid rise to supranormal levels, with return to normal after about ten minutes. Fluctuations in arterial pressure were practically absent with 70 per cent Urokon.

Aortography performed up to twenty-four hours after the introduction of oxygen into the retroperitoneum (pneumography) has been found advantageous in the diagnosis of retroperitoneal masses, especially with stereoscopic views.

Aortography is an important tool in differentiating renal adenocarcinoma and cyst. Cysts appear as relatively blank areas, with impaired (or absent) arterial supply, circumscribed by intrarenal arteries. Renal adenocarcinoma typically shows extensive pooling of the contrast medium owing to necrotic regions with relatively dilated blood channels. In the differentiation between neoplasm and cyst, the authors were correct in 46 cases out of 49. Unless the patient is a poor risk or refuses surgery, all solitary cysts, even when diagnosed by aortography, should be explored, because of the possibility that they be adenomas. The prevailing opinion is that papillary cystadenomas, tubular adenomas, alveolar adenomas and the various intergrades are potentially precancerous. Pooling of the contrast medium in the kidney indicates the necessity for its wide extirpation, if possible without entering the perirenal fascia (Gerota's). An aortogram, by revealing the necessity for radical surgery, may save a patient's life.

By mapping the position and course of the renal artery, aortography demonstrates the readiest approach to the renal pedicle in cases of renal neoplasm. The procedure can also depict polar and aberrant renal arteries and disclose the amount of kidney supplied by these vessels. In the diagnosis of polar artery the authors were correct in all of 11 cases confirmed by surgery. The extent of stretch and narrowing of interlobular arteries in hydronephrotic "non-functioning" kidneys can also be demonstrated, thus showing whether such kidneys are viable.

The density of a nephrogram taken immediately after transaortic injection of the contrast medium is a good index of renal function. In cases of congenitally dilated renal pelves and ureters it also serves to outline the extent of the renal parenchyma.

When retrograde pyelography shows a non-functioning kidney of normal or appreciable dimensions, it can be determined by aortography whether or not the renal artery is obstructed. The presence or absence of a kidney can also be established.

Caval phlebography was performed in 20 cases. In 4 of 8 patients with renal or adrenal neoplasm there was partial to complete obstruction of the inferior vena cava. Obstruction of the inferior vena cava, however, is not itself proof of inoperability or of vascular extension. In 1 case obstruction was found, at autopsy, to be due solely to external pressure by the advanced neoplasm. Conversely, renal adenocarcinoma with extension to the spleen, diaphragm, and liver need not involve the inferior vena cava grossly. Caval phlebography should be a preoperative routine for every case of diagnosed adenocarcinoma of the kidney.

Seventy-two roentgenograms; 2 photographs; 2 tables.

A Criticism of Renal Angiography. Tom E. Nesbitt. Am. J. Roentgenol. **73:** 574–583, April 1955.

At the time of this report, renal arteriography had been employed in 200 patients at the University of Michigan Medical School. The series represents a selected group of patients chosen as candidates for the procedure primarily because accepted methods of investigation had not provided sufficient information to guide further treatment, and it seemed reasonable to expect that arteriography might supply this lack. An attempt was made to examine objectively the value of aortography and to appraise, as frankly as possible, each case, to determine in what way arteriography affected the clinical management. With few exceptions, aortography failed to furnish information which altered the normal course of events.

Arteriography almost always enables one to differentiate between renal tumor and renal cyst. It is

usually the accepted policy, however, to expose such lesions surgically, and under these circumstances aortography becomes a superfluous procedure.

In adrenal disease arteriography has been disappointing. It must be realized that the limitations on adequate interpretation and technic of performance are many. Ideally, one would prefer to visualize only the renal or adrenal circulation and avoid filling the other branches of the abdominal aorta. This is practically impossible with the translumbar route. It may be that percutaneous femoral artery catheterization with a polyethylene catheter to the renal artery level will provide greater accuracy of interpretation and diagnosis.

In the present series, renal angiography was found to be of practically no benefit in the study of patients with renal hypertension. The axiom that a kidney is only as good as its blood supply is a valid one. An accurate radiologic appraisal of the blood supply, however, often proves to be very difficult. Renal function can be measured more exactly with the creatinine or urea clearance tests.

Arteriography would seem to be of value in the patient with polycystic disease where surgical intervention for diagnosis is imminent. It would also appear to be of assistance in dealing with intrinsic structural anomalies of the renal vessels as encountered in renal fusion, fused ectopia, and aneurysm. The adept surgeon, however, will continue to place reliance upon his skill in dissection at the operating table in these difficult problems.

Eight cases illustrating the shortcomings of renal arteriography are reported, not to condemn the procedure as a whole but to point out the necessity for more careful selection of patients. If one can say in advance that the investigation will be a deciding factor in the choice of a method of treatment, then its use is warranted. Otherwise, there seems to be little justification for its performance.

No attempt is made to present the favorable aspects of renal arteriography as they have been previously set forth in the literature.

Twenty-three roentgenograms.

Aortography in Renal Artery Aneurysm. Jacob Anthony Begner. J. Urol. **73:** 720–725, April 1955.

Aneurysm of the main renal artery is relatively rare. Ninety-three cases have been recorded, and in all but 17 of these the diagnosis was made either at autopsy or too late for surgery. The x-ray findings have been variously described as calcification in or near the kidney, usually circular in form and often incomplete and deficient in places. The location is generally anterior to the renal pelvis and medial to the upper third of the kidney. The shadow has been referred to as "wreath- or ring-like." In all descriptions of this ring-like shadow, the only constant finding has been the presence of more or less parallel calcified lines bordering the radiolucent lumen of the vessel. The renal pelvis and the upper calyces may be deformed.

The author presents a case of true aneurysm of the left renal artery. In this case the radiolucent lumen of the aneurysm was successfully filled with contrast medium at aortography, so as to cause it to become radiopaque and demonstrate unerringly that it was part of the vascular system of the kidney. The diagnosis was confirmed at surgery.

Six roentgenograms; 2 photographs.

Hypertension Associated with Renal Artery Aneurysm and Relieved by Nephrectomy. Bernard H. Pastor, Ralph M. Myerson, George T. Wohl, and Paul V. Rouse. Ann. Int. Med. **42:** 1122–1130, May 1955.

Well documented examples of hypertension produced by unilateral renal lesions are relatively rare. The importance of recognizing such lesions is obvious, since this form of hypertension is curable. The introduction of newer diagnostic technics, including aortography, has facilitated their identification.

By means of translumbar aortography, the authors demonstrated an unsuspected aneurysm of the renal artery in a young adult male with hypertension. Following nephrectomy, the hypertension was completely relieved. The absence of pathologic changes in the kidney in this instance, except for atrophy and necrosis, seems to exclude underlying renal disease as the etiologic factor of the hypertensive state. The case probably represents a true example of hypertension caused by unilateral renal ischemia, secondary to renal artery obstruction.

Aortography greatly facilitates the diagnosis of vascular abnormalities of the renal artery. In instances where catheterization is of advantage, the necessity for exposure of the femoral artery has been obviated by the development of a technic for the introduction of a polyethylene catheter percutaneously through a large bore needle.

Before the use of aortography, cases diagnosed preoperatively were identified chiefly by the presence of a characteristic signet-ring or wreath-shaped calcification along the medial border of the kidney, in conjunction with the clinical history. Such calcification, however, was present in only 33 of the previously reported 119 cases. In 6 cases it was apparently interpreted as due to some other lesion. Nor is calcification, when present, diagnostic of renal artery aneurysm, since the aneurysm may be in some other site, such as the splenic artery. In some cases stereoscopic views or laminagraphy have been helpful in demonstrating the relationship of the calcific density to the kidney.

The literature on renal artery aneurysm and renal hypertension is briefly reviewed.

Three roentgenograms. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Renal Function Following Aortography Carried out Under Ganglionic Block. Herman Lodin and Lars Thorén. Acta radiol. **43:** 345–354, May 1955.

Lindgren introduced a technic of aortography, under anesthesia, with hypotension, the blood pressure being reduced to about 85 mm. of Hg with a barbiturate (Acta radiol. **39:** 205, 1953. Abst. in Radiology **62:** 149, 1954). This was found to be advantageous in that the nephrographic effect was increased. The present authors describe a method of accomplishing the same results with tetra-ethyl ammonium bromide injected intravenously. During hypotension induced by this method, there is a decrease in arteriolar tonus due to an interruption of the vasoconstrictor pathways. It has been shown that tetra-ethyl ammonium bromide produces a significant fall in the renal blood flow and glomerular filtration rate despite only a moderate fall in blood pressure.

The present investigation showed no impairment of renal function in 15 patients examined under ganglionic block. Among 40 other patients studied earlier by this method, there was a single case of temporary

renal failure. The authors thus believe that the risks of renal damage are minimal.

It was found that by using tetra-ethyl ammonium bromide the examination could be performed without a general anesthetic and with the patient suffering no great discomfort.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Hypaque, A New Urographic Contrast Medium. Joseph C. Root and William C. Strittmatter. Am. J. Roentgenol. **73:** 768–770, May 1955.

The authors report their experiences with Hypaque, in a series of 350 patients, each of whom received 25 c.c. of the medium intravenously. Hypaque contains 59.8 per cent iodine by weight, as compared with Urokon sodium, which contains 65.8 per cent, Diodrast 48.9 per cent, and Neo-Iopax 51.5 per cent.

The results of the studies are tabulated, and it is concluded that the value of Hypaque as a urographic contrast medium is twofold: it makes possible excellent visualization of the urinary tract and diminishes the number of post-injection reactions. Less than 10 per cent of the patients in this series showed any type of reaction, and in general the urograms were excellent.

Three tables.

THEODORE E. KEATS, M.D.
University of California, S. F.

Clinical Evaluation of a New Compound for Intravenous Urography. M. Rollins, F. J. Bonte, F. A. Rose, and D. R. Keating. Am. J. Roentgenol. **73:** 771–773, May 1955.

The authors report their experience with Hypaque, a new compound for intravenous urography. The results with Hypaque 50 per cent used in 100 cases are compared statistically and clinically with the results in 100 cases in which Neo-Iopax 50 per cent was employed.

Hypaque produced superior visualization but there was no difference in incidence or type of patient reactions. The excretion rates of the two compounds appeared to be clinically similar. The usual examination can be completed in approximately twenty minutes.

Two tables.

THEODORE E. KEATS, M.D.
University of California, S. F.

Arterial Infarction of the Kidney. J. George Teplick and M. William Yarrow. Ann. Int. Med. **42:** 1041–1051, May 1955.

Arterial occlusion of the kidney with infarction is not uncommon but its clinical recognition is extremely rare. Occlusion of the renal artery or its branches is usually due to emboli secondary to cardiac disease, but atherosclerosis of the renal vessels may in some instances be responsible. Trauma to the renal area may also produce arterial occlusion and infarction.

The diagnosis of arterial occlusion of the kidney can usually be made from combined clinical, laboratory, and roentgen studies. The onset is sudden, with sharp unremitting pain in the upper abdomen or flank, rise in temperature, and, in some cases, vomiting. Within a few hours the pain settles to the flank and persists from two to four days, with discomfort gradually diminishing after this period. The immediate picture can simulate an acute abdominal condition. Albuminuria will appear in most instances, and red blood cells are found in the urine in at least half the cases.

The intravenous urogram will reveal a non-functioning kidney on the affected side. The retrograde pyelogram, however, will show the renal pelvis, calyces, and ureter to be normal. The cystoscopist will find little or no urinary flow from the affected kidney. A non-functioning kidney of normal size in conjunction with a normal retrograde pyelogram can thus be considered diagnostic of arterial occlusion of the renal artery. Confirmatory radiologic evidence can be obtained by aortography, with demonstration of non-filling of the affected vessels.

Two cases, illustrative of the typical clinical, laboratory, and x-ray findings of renal arterial occlusion, are reported.

Significant return of kidney function after renal infarction is not usually observed, even after a considerable time lapse. Recovery has, however, been noted in a few cases, generally within a few months.

In bilateral occlusion, the clinical picture is more shock-like in onset, with pain in both flanks. Anuria, distention, and a uremic death follow.

It is noted that the roentgen appearance of a kidney, months after an undiagnosed acute arterial occlusion, can easily be misinterpreted. The shrunken non-functioning kidney with atrophied pelvis and calyces may be taken as indicating chronic atrophic pyelonephritis. Cystic degeneration of an infarcted area, with distortion of the affected calyx, may simulate a renal tumor or cyst.

Infarction from occlusion of the renal vein must be distinguished from the arterial type. As in arterial infarction, the kidney is non-functioning, but a retrograde pyelogram will show the pelvis to be narrowed or even completely occluded. Unless nephrectomy is performed, death may follow.

Five roentgenograms; 1 table.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Calyceal Diverticulum. Raymond M. Yow and R. Carl Bunts. J. Urol. **73:** 663–670, April 1955.

The authors found in the literature 82 cases of calyceal diverticulum or cases which they believed to be calyceal diverticulum. They report 14 cases of their own and an additional 5 which came to their attention.

Fourteen of the 19 patients complained of pain, and in 7 this was the only subjective finding. It ranged from acute severe colic to an annoying intermittent aching flank pain of several months duration. Calculi occurred in 10 cases—in 8 solitary calculi and in 2 aggregates of many small calculi. Pyuria was found in 10 patients; in 5 the infection was sufficient to produce chills and fever.

The diagnosis of calyceal diverticulum is made by the roentgen demonstration of a saccular structure communicating with a calyx by means of a narrow channel. While excretory urography is adequate for this purpose in most instances, occasionally retrograde studies may be necessary. In the differential diagnosis hydrocalyx, localized obliterating pyelonephritis, parapelvic cyst, simple cysts, and tumor must be considered. *Hydrocalyx* is a dilatation of a calyx due to a pathological condition of the infundibulum, either a calculus or inflammatory reaction. Roentgen evidence of infundibular changes may be seen in a hydrocalyx, but in calyceal diverticulum the infundibulum is usually of normal configuration. *Localized obliterating pyelonephritis* is an inflammatory lesion which progresses to complete obliteration of a calyx. Confusion between it and calyceal diverticulum may arise as the calyx becomes narrowed. Only by serial x-ray studies is it possible to

differentiate between the two conditions clinically. *Parapelvic cyst* is a low cuboidal cell-lined cyst lying adjacent to, but not communicating with, the renal pelvis. It does not fill with contrast material unless an inflammatory process has caused a communication with the renal pelvis. *Simple cysts* likewise do not communicate with the renal collecting system; they usually lie in the cortex of the kidney, although medullary cysts do occur.

In the authors' experience the most satisfactory method of treatment has been the total removal of the diverticulum with obliteration of the channel communicating with the renal pelvis. Eleven patients in the present series were treated surgically.

Five roentgenograms; 1 photograph; 1 table.

THE ADRENALS

Adrenosympathicoblastoma Producing a Cushing Syndrome. G. Kis-Várday. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 610–614, May 1955. (In German)

A Cushing syndrome as a result of hyperfunction of the adrenal cortex is ordinarily not seen in medullary tumors of the adrenals. The author reports such a case in a seventeen-year-old girl with a history of pain along the sciatic nerve for three years. Definite signs of a Cushing syndrome were present (striae along the hips and on the breasts, development of a mustache, menstrual disturbances, etc.). The right kidney was displaced downward. Above it some small calcifications were demonstrated, and a roentgenogram taken after air insufflation of the perirenal fatty tissue plainly showed a tumor of the adrenal the size of a small fist. This was surgically removed and microscopic examination disclosed a ganglioneuroma without evidence of malignancy. Within two months the Cushing syndrome had completely disappeared, but the course was downhill, with development of a tumor of the right ilium. Surgical biopsy of this tumor showed it to be a sympathicoblastoma.

The removed right adrenal showed no hyperplasia of the cortical tissue. On the contrary, only small islands of cortical cells were present. The author believes that a marked compensatory hypertrophy of the left adrenal had occurred and that this was responsible for the development of the Cushing syndrome. He further holds that malignant cells of a sympathicoblastoma may be transformed into benign ganglioneuroma cells and *vice versa*, and Cushing and Wolbach are quoted in support of this view. The rarity of a Cushing syndrome associated with tumors of the medulla is attributed to the fact that these tumors generally occur in early childhood.

Three roentgenograms; 2 photomicrographs; 2 photographs. WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

A Diagnostic Aid for Visualization of the Left Suprarenal Space. Frank C. Hamm and Louis J. Scordamaglia. J. Urol. **73**: 885–887, May 1955.

In the diagnosis of tumors of the renal area by presacral air injection, confusing shadows are more commonly found on the left side. Among these is that produced by the contracted fundus of the stomach. This can be eliminated by distending the stomach with gas. For this purpose the authors use a gas-producing agent, consisting of sodium bicarbonate and tartaric acid. The bicarbonate (half a teaspoonful in an ounce of water) is taken first, followed immediately by the tartaric acid (in similar solution). When in contact with the hydrochloric acid of the stomach and the tartaric acid, the bicarbonate liberates CO_2. A roentgenogram is obtained immediately.

It is the authors' belief that distention of the stomach combined with perirenal air studies will clearly demonstrate the left suprarenal area exclusive of all shadows except those of the adrenal gland, kidney, and spleen.

Six roentgenograms; 6 drawings.

G. M. GREENWALD, M.D.
Cleveland Clinic

TECHNIC

Use of Polyethylene Tubing in Presacral Pneumography. George T. Wohl and Ralph M. Myerson. J. Urol. **73**: 883–884, May 1955.

A modified method of peritoneal air or oxygen insufflation by the presacral route involving use of polyethylene tubing for delivery of the gas is presented.

Use of the tubing is more convenient for the operator, and more comfortable for the patient. Need for continued presence of a needle in the retrorectal tissue is eliminated. Injection under fluoroscopic guidance is facilitated, and the patient can be positioned with greater ease to deliver the gas to the desired area.

One photomicrograph. C. M. GREENWALD, M.D.
Cleveland Clinic

Equivalent Conditions of Projection in Roentgen Diagnosis. E. Zieler. Acta radiol. **43**: 393–408, May 1955. (In German)

The effect of the variation of the tube voltage upon the exposure time in roentgenography with intensifying screens was investigated by means of measurements in water phantoms. From these experimental results it is shown that the exposure data depend on the wave form of the tube voltage. An empirical formula is reached for the relation between the photographic absorption coefficient for water and the tube voltage. The experiment was performed with the secondary radiation efficiently suppressed.

Twelve diagrams.

MISCELLANEOUS

Observations on Progressive Scleroderma (Changes in Esophagus, Cataract, Death from Carcinoma). Horst Dörken. Radiol. clin. **24**: 156–161, May 1955. (In German)

The lung and the esophagus are the internal organs most commonly involved in scleroderma. Disease of these structures, however, does not necessarily parallel that of the skin. The lung changes, which consist of fibrosis and small cysts, may actually precede the skin lesions. Of the esophageal changes, atony is the best known, occurring in about 50 per cent of all cases. The histologic picture resulting from secondary chronic inflammation caused by regurgitation and stasis is not easy to evaluate apart from the primary changes. Atony of the small intestine, which might be associated with a disturbance in absorption of fats, is also recognized.

In 1951 the author reported a case of scleroderma with esophageal involvement (Radiol. clin. **20**: 129, 1951. Abst. in Radiology **58**: 605, 1952). The patient has since died and the present report includes the later clinical and autopsy findings. In addition to an esophageal ulcer with atony and stenosis, and a sliding

hernia, there was a primary bronchial carcinoma with metastasis to the lumbar spine.

Though several cases have been reported, the association of cancer and scleroderma is rare. In dermatomyositis malignant tumors are much more common.

In the case recorded here, there were also striking changes in the lens. A brief review of the literature on this point is given. While these eye findings are not common, they should be borne in mind.

Two roentgenograms; 1 photograph.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

RADIOTHERAPY

Radiation Therapy of Cancer of the Buccal Mucosa and Lower Gingiva. Isadore Lampe. Am. J. Roentgenol. **73:** 628–635, April 1955.

During the period 1940 to 1955, 50 previously untreated cases of cancer of the buccal mucosa were treated by irradiation at the University of Michigan Medical School. During the same period, 40 patients with untreated cancer of the lower alveolar mucosa were seen; 1 of these left for treatment elsewhere. Recurrent lesions are not considered in this report.

Cancer of the Buccal Mucosa: Well differentiated squamous-cell carcinomas predominated in this series of 50 cases: 8 were classified histopathologically as Grade 1, 28 Grade 2, 13 Grade 3; 1 was ungraded. Ten of the lesions were advanced to the extent of involving essentially the entire buccal mucosal area, and some of these extended beyond this region. Eleven patients had metastases on admission, either near the angle of the mandible or further anteriorly in the submaxillary area; treatment failed in 8 of these cases. In 5 patients metastases subsequently developed. With the exception of 1 patient successfully treated by irradiation for a carcinoma of the floor of the mouth eleven years previously, whose buccal lesion was treated by interstitial radium, all patients received roentgen therapy. Thirty-three were treated by external irradiation only, 9 by peroral irradiation only, and 7 by a combination of external and peroral irradiation. Of 30 patients eligible for five-year survival rate computation, 50 per cent were alive without neoplasm at five years. For the entire group of 50, an estimated five-year survival of 46.4 per cent has been computed.

Cancer of the Lower Gingiva: Of the 39 cases of cancer of the lower alveolar mucosa, 33 were classified histopathologically as Grade 2, 3 as Grade 3; 3 were not graded. Eight of the tumors were 3 cm. or less in diameter; 9 were larger but still confined to the alveolar mucosa. Thirteen had extended beyond the gingiva to involve regional structures, without metastasis. Nine cases presented lymph node metastases; in 14 cases there was roentgen evidence of invasion of the mandible.

None of the 9 patients with lymph node metastases were subjected to neck dissection, either because of advanced age or advanced status of the primary lesion or the metastatic disease; 8 died with carcinoma (the longest survival was thirty-one months) and the ninth died of other causes six and a half years after treatment, without recurrence. In 3 other patients cervical node metastases developed within one year of irradiation. Twenty-seven patients received external roentgen irradiation, 5 peroral irradiation, and 7 a combination of external and peroral irradiation. Of 27 patients eligible for five-year survival rate computation, 29.6 per cent were alive without neoplasm at five years. For the entire group of 39 patients, the computed estimated survival rate was 33.4 per cent. Of 14 cases with unequivocal bone destruction, 4 were without recurrence at five years.

Four roentgenograms; 8 photographs; 1 graph.

Radiotherapy of Cancer of the Tongue and Floor of the Mouth. C. L. Ash and O. B. Millar. Am. J. Roentgenol. **73:** 611–619, April 1955.

This paper on oral cancer is based on a series of patients seen at the Ontario Institute of Radiotherapy and the Department of Radiotherapy, Toronto General Hospital, during the period from 1929 to 1949. The five-year studies cover 394 cases of cancer of the tongue and 95 cases of cancer of the floor of the mouth.

In general, it is felt that primary lesions of the oral cavity, including the lip, are best managed by radiotherapy, while metastatic nodes in the neck are more adequately treated by radical surgery. All the various forms of radiation that have been suggested at one time or another have been employed—radium in the form of molds, needles, radon seeds, teleradium; roentgen rays of 200 to 400 kv; intraoral roentgen rays generated at 88 to 200 kv. Not infrequently diathermy has been used in association with the above measures. In the more bulky lesions, or in those that are ulcerated, with overhanging indurated margins, more satisfactory results are obtained if this profuse tissue is removed by electrocoagulation prior to, or at the time of, irradiation.

Radium, usually in the form of needles, but occasionally as gold radon seeds, is used in localized lesions of the tongue and floor of the mouth. In more advanced lesions, it is too difficult to achieve an even dosage and the risk of not covering the entire area of involvement is too great for the employment of radium needles alone. Initially, such lesions are best treated by external irradiation, supplemented if possible by intraoral roentgen therapy. Small residual masses are ordinarily treated by an interstitial radium implant, occasionally combined with electrocoagulation.

Carcinoma of the Tongue: In 217 of the 394 cases of lingual carcinoma (55 per cent), the lymph nodes were involved either on admission (131 cases) or later (86 cases). The gross five-year survival rate for the entire series was 27.2 per cent and the net survival rate 31.7 per cent. The primary lesion was controlled by the initial treatment in 60.4 per cent of 159 cases treated by interstitial radium, in 32.9 per cent of 152 cases treated by external radiation, and in 63.6 per cent of 66 cases in which both procedures were used. In 32 patients with early cancer, the recurrent primary lesion was controlled by subsequent treatment in 12; in 21 with late cancer, the recurrent lesion was controlled in 5.

Carcinoma of the Floor of Mouth: In 43 of the 95 cases of carcinoma of the mouth (44.3 per cent), the lymph nodes were involved on admission in 21 cases and later in 22 cases. The gross five-year survival rate for the series was 38.9 per cent and the net survival rate 43.2 per cent. The primary lesion was controlled by initial treatment in 63.2 per cent of 19 cases treated by interstitial radium, in 28.0 per cent of 50 cases treated by external radiation, and in 41.7 per cent of 24 cases in which both procedures were used. In 19 patients with

early cancer, the recurrent primary lesion was controlled by subsequent treatment in 8; in 11 with late cancers, the recurrent lesion was controlled in 4.

By initial treatment is meant treatment administered within three months. "Controlled" indicates that the primary lesion remained healed for a period of five years or until the time of death.

From the observations made in this series of cases, it would seem that the most effective method of dealing with the primary lesion in cancer of the tongue or floor of the mouth is by interstitial radium or a combination of this with some form of external irradiation. External irradiation alone, which includes teleradium and intraoral roentgen therapy, gives the poorest results.

By crossing the open ends of the radium implant with full strength needles and using half strength needles in the central portion of the implant, a more even dose distribution is obtained, with resultant diminution of undesirable sequelae.

Six figures; 11 tables.

Radium Therapy for Carcinoma of the Floor of the Mouth. Juraj Körbler. Radiol. clin. **24:** 187–191, May 1955. (In German)

Implantation of radium needles into the floor of the mouth from within is associated with unavoidable dangers and technical difficulties, such as infection and inexact distribution of the needles, as well as discomfort to the patient. The author introduces the needles through the skin and finds that they are thus better tolerated by the patient and can be removed without complications. Nerves and vessels cannot be damaged by such implantation. Because the procedure is better borne by the patient, treatment can be prolonged as much as necessary.

Two roentgenograms; 2 photographs.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Cancer of the Larynx. Five-Year Results, with Emphasis on Radiotherapy. C. C. Wang and A. R. O'Donnell. New England J. Med. **252:** 743–747, May 5, 1955.

An evaluation of the results of radiotherapy in a group of 253 patients with cancer of the larynx is presented. All of the cancers arose on the vocal cords or had extended to involve the immediately adjacent structures. All were histologically proved. The cases were seen at the Massachusetts General Hospital from 1931 to 1949, allowing a minimum follow-up of five years.

Approximately two-thirds of the patients were in the sixth and seventh decades and 95 per cent of the group were males. Histologically all but one of the tumors were squamous-cell carcinoma. The single exception was an adenocarcinoma.

The analysis of the 253 cases is given in clear, concise tabular form, according to the stage of the disease. It shows that early laryngeal cancer, Stage 1 or 2, can be treated by either radiotherapy or surgery with a high degree of success. The preservation of a useful voice, however, makes radiotherapy the treatment of choice.

In the advanced stages of cancer of the larynx a trial of radiotherapy may be carried out when careful observation is possible. If the disease is not controlled, radical surgery is still available.

The closest co-operation between the radiologist and otolaryngologist is essential if maximum benefit is to follow the treatment of this disease.

One roentgenogram; 5 drawings; 5 tables.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Dosage in Tangential Radiation Therapy of the Postoperative Breast Portal. David J. Lochman. Am. J. Roentgenol. **73:** 803–812, May 1955.

Following operation for breast carcinoma the author attempts to deliver a radiation dose of 5,500 to 6,000 r to the potential tumor-bearing tissue. This treatment is given eight to twelve weeks after surgery. The high dosage necessitates the use of tangential fields to reduce the danger of radiation pneumonitis and fibrosis of the underlying lung.

A study of the amount of irradiation to the chest wall, with and without bolus material, was undertaken. All the measurements were made with Type C Sievert-Rose condenser chambers, 20 mm. long, with a diameter of 5 mm. The thoracic fields under treatment were divided into 16 quadrilaterals, four rows of four each, and a chamber was placed in the center of each quadrilateral. With the technic used the measured dose was within 5 per cent of the actual surface dose.

Treatment was begun as soon after surgery as wound healing was complete. The patients received radiation to anterior and posterior portals arranged to cross-fire the axillary, supraclavicular, and inferior cervical lymphatic tissue. Treatment was also given to the anterior chest wall by means of two tangentially placed portals. The technical factors were 250 kvp, h.v.l. 1.4 mm. Cu, target-skin distance 50 cm.

The dosage measurements in this series of patients indicated that there is slight improvement in evenness of dosage over the chest wall when bolus is omitted. It was also concluded that reliance should not be placed on the tangential radiation for treatment of the internal mammary lymphatics or of the infraclavicular area. General correlations between measurements and depth dose estimations from published charts can be made, but appreciable errors are possible, especially near the margins of the field.

Two photographs; 1 chart; 4 tables.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

Pituitary-Radon Implant for Breast Cancer. A. P. M. Forrest and D. A. Peebles Brown. Lancet **1:** 1054–1055, May 21, 1955.

Total ablation of the pituitary gland has proved beneficial in some cases of advanced breast cancer. The authors make a preliminary report of a method, which was evolved at the Western Infirmary, Glasgow, of destroying the pituitary by implanting radon seeds, thus obviating the necessity for open operation. Under general anesthesia and antibiotic cover, the seeds are introduced through a cannula inserted into the pituitary fossa through the nose and the sphenoid sinus. Radiographs are taken throughout the procedure to check the alignment of the cannula and finally to confirm its position in the pituitary fossa.

At the time of the report 9 cases of advanced cancer had been treated by the method described, without mortality or morbidity. All the patients complained of headache on the evening of the operation, but in no instance did this persist beyond the second postoperative day. In only 1 case was the convalescence com-

plicated by evidence of infection. Patients are ambulant the day after the implant, and are discharged from the hospital in six days. The simplicity of the method allows its use in cases unsuitable for major surgery, and the authors believe that it may prove as effective as, but less hazardous than, total adrenalectomy and oöphorectomy.

Four roentgenograms; 1 photograph.

Cancer of the Esophagus. Charles B. Puestow, William J. Gillesby, and Vernon L. Guynn. Arch. Surg. **70:** 662–668, May 1955.

The authors present an analysis of 603 cases of carcinoma of the esophagus seen at the VA Hospital in Hines, Ill., during the past twenty-three years. For the first fifteen years of this term, the hospital served as a tumor center. More recently it has been a general hospital.

The incidence of esophageal carcinoma during the past few years has represented about 0.1 per cent of total hospital admissions and 3 per cent of admissions for primary malignant disease. In contradistinction to the markedly increased incidence of lung carcinoma, there seems to have been little change in the rate of occurrence of cancer of the esophagus.

Approximately 90 per cent of esophageal carcinomas are found to be of the squamous-cell variety; about 10 per cent are adenocarcinomas. The prognosis of adenocarcinoma of the esophagus is definitely better than that of the squamous-cell lesion. In an analysis of the cases in one year, it was found that the average hospital survival for the former was 181 days, and for the latter 46.8 days. Analysis of 100 consecutive cases coming to autopsy revealed a high percentage of pulmonary complications. Bronchopneumonia occurred in 48 cases.

Radiation therapy through multiple ports was used in some patients in this series. Although comparison of survival times suggests the value of x-ray therapy, the authors stress the risks involved in this procedure. Two of their patients died as a result of activation of tuberculosis. Perforation of an esophageal carcinoma into the pleural cavity with fatal empyema also occurred. Many patients were admitted with lung abscesses, empyema, and pneumonitis, which contraindicated radiotherapy.

The authors prefer surgical intervention. Curative procedures are possible in some cases, and recent years have shown a decrease in operative mortality. Survival charts for patients treated surgically and by irradiation are presented. From these it would appear that the longer survival time with resection justifies its performance in appropriate cases. The longest survival was three years and seven months in a patient treated by resection and esophagogastrostomy without irradiation. Death was due to a coronary occlusion, and no carcinoma was found postmortem.

Ligation of the esophagus in the early stages of a resection, above and below the tumor, is advised to prevent exfoliation and inclusion of carcinoma cells in the line of suture. Lymphatic spread of the disease is probably more extensive than has been realized, and it is believed that surgical excision will have to be extended if better results are to be obtained.

Three charts; 7 tables; 1 drawing.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Concerning Convergent Therapy of the Bronchiogenic Carcinoma. Werner Hellriegel. Strahlentherapie **97:** 119–123, May 1955. (In German)

Of 250 cases of bronchial carcinoma treated by irradiation between 1951 and 1953, 101 were given convergent beam therapy. The latter procedure has a distinct advantage over the cross-fire technic because massive tumor doses—9,000 r and higher—can be given without causing permanent damage to the skin. The surrounding healthy tissues also show less damage. Fewer side-effects are noted, and the defense mechanism is less impaired than with cross-firing.

With smaller tumor doses, especially those below 6,000 r, the chances of curability and survival are greatly diminished. With a tumor dose of less than 4,000 r only 6.5 per cent of the patients survived one year; with 9,000 r and more the survival rate was increased to 50 per cent.

A case is reported in which a tumor dose of 10,000 r was given with a convergent beam. Nine months later, when the patient died from atrophy of the liver, the lungs were found to be free from neoplasm.

Four tables.

ERNEST KRAFT, M.D.
Newington, Conn.

A Bead Packing Technique for the Application of Uniform Doses of Irradiation to the Endometrial Cavity. An Experimental Approach. Charles H. Hendricks, George W. Callendine, and Joseph L. Morton. Am. J. Obst. & Gynec. **69:** 1039–1050, May 1955.

This report concerns the development of an experimental method to provide a more uniform application of multiple small sources of radioactive material to the uterine cavity. Small metal spheres containing Co^{60} are threaded like beads on a strong suture. The uterine cavity may be readily and uniformly packed with the beads. Equipment and technic of application are presented in detail.

Ten surgically removed uteri were studied after injection of Lipiodol, following insertion of a dummy tandem application, and after packing with beads. The mass of beads closely approximated the contour indicated by Lipiodol; the relationship of the tandem and uterine cavity, especially when the cavity was distorted, left much to be desired.

With the bead-packing technic, the maximum-to-minimum dose ratio over the outer wall of the uterus can vary from a little less than 3.0 for a linear pattern to an approach to the ideal 1.0 for a triangular pattern. In view of this low maximum-to-minimum range, the authors suggest an empirical prehysterectomy dosage of 2,500 to 4,500 r as adequate for the outer uterine wall, taken as 1.5 cm. from the endometrial surface. Dosage tables have been worked out for several patterns and varying numbers of beads. Total treatment time of three to four days may be maintained, when a large number of beads is required, by varying the individual bead loading.

Five roentgenograms; 3 photographs, 4 drawings; 2 tables.

R. L. EGAN, M.D.
M. D. Anderson Hospital, Houston

Radiation Therapy of Induratio Penis Plastica (Morbus Peyronie). A. Pickhan. Strahlentherapie **97:** 101–104, May 1955. (In German)

The author treated 85 cases of induratio penis plastica from 1946 until 1954. He prefers radium to other

forms of radiotherapy and claims that with proper filtration and with protective covers genetic damage can be prevented. Supplementary roentgen therapy is sometimes necessary in deep-seated infiltration of the septum intercavernosum.

Roentgen therapy alone is inadvisable because of possible damage to the skin. Contact therapy is especially contraindicated because of the severity of the skin reaction. It is useful, however, in associated Dupuytren contracture, which was present in 15 cases of this series.

Supportive measures with vitamin E and other medication have been tried, but have not been very helpful.

The results with radiation therapy have been encouraging so far, and tend to disprove a prevalent pessimistic attitude.

ERNEST KRAFT, M.D.
Newington, Conn.

Calculation of Dosage in Vertical Rotation Therapy Using Standard Isodose Charts. Victoria Castro, Charles Soifer, and Edith H. Quimby. Am. J. Roentgenol. **73:** 815–826, May 1955.

Rotation therapy is a useful technic in the conventional voltage range as well as with supravoltage equipment. With either it is desirable to know doses delivered both inside and outside the tumor. Since dosage calculations for supravoltage therapy are based on certain assumptions which do not hold for lower voltages, the authors have based their calculations on standard isodose curves for the beams actually used. Comparison of phantom measurements and dosage as calculated by their system has shown close agreement.

Briefly, the procedure is as follows: The contour of the region to be treated is drawn on translucent material with an outline of the tumor included. This drawing is placed over a celluloid base marked off in polar coordinates, with 12 segments of 30° each. The distance from the center of rotation to the skin is then found for each segment and by use of these distances and the inverse-square law (the authors have devised a chart for their particular factors) the twelve 100 per cent air doses are recorded. The appropriate isodose chart is centered over the axis of each segment to record the instantaneous percentage depth dose for each point considered. Next, the percentage depth dose is multiplied by its corresponding 100 per cent air dose to obtain the instantaneous tissue doses at that point. The average of all 12 partial tissue doses is the dose delivered to the point per 100 r in air at the distance of the axis of rotation.

Twelve figures; 5 tables. J. A. GUNN, M.D.
Grand Rapids, Mich.

High-Pressure Oxygen and Radiotherapy. I. Churchill-Davidson, C. Sanger, and R. H. Thomlinson. Lancet **1:** 1091–1095, May 28, 1955.

The authors describe a preliminary investigation of the effects of irradiating carcinomas in patients breathing oxygen at a pressure of three atmospheres absolute (30 lb. per square inch gauge pressure). To obtain results quickly, they tried to determine whether the expected increase in radiosensitivity was demonstrable histologically. For this purpose, they treated patients with carcinomas large enough to be divided into two fields. One field was irradiated with the patient breathing air at atmospheric pressure, and the other with the patient breathing oxygen in a pressure chamber. Each field was irradiated only once, with the same dose of x-rays. To compare the effect on the two fields, a tumor dose (1,000–1,500 r) was administered which was insufficient to kill all the cells. After an interval, a biopsy specimen was taken from each field, or the growth was excised, and the pathologist was told only where the dividing line between the two fields lay.

Eight patients were irradiated: 4 with carcinoma of the lung and 4 with carcinoma of the breast (2 were local recurrences after mastectomy). The breast tumors were treated through two anterior fields and were divided by covering one-half with lead sheets. The lung tumors were treated through directly opposing anterior and posterior fields. The x-ray apparatus was a standard 250-kv unit, with filtration to give a half-value layer of 1.70 mm. Cu (in treating one of the breast tumors this was reduced to 1.17 mm. to give a higher dosage rate). Patients were anesthetized before the administration of oxygen. Bilateral myringotomy was also carried out to prevent extensive rupture of the tympanic membrane or middle ear hemorrhage.

The pathologist was not told which part of the tissue had been irradiated in air and which in oxygen. In 6 cases the tissue which he reported to be the more damaged was that irradiated in oxygen. This was also probably true of another case. In the remaining case no distinction was made because none of the tumor cells in either field had survived. A continuation of the investigation, using potentially curative doses to the whole tumor, is planned.

Four illustrations, including 1 roentgenogram.

RADIOISOTOPES

Radioactive Isotopes in a Community Hospital. John W. Turner. New England J. Med. **252:** 806–809, May 12, 1955.

Investigations into the use of various radioactive isotopes was under way long before the era of the atomic bomb. Numerous papers by Hertz (1938), Lawrence, and others showed many biologic and medical applications of the radioactive isotopes. The marked increase in their availability since 1946 due to the Oak Ridge uranium-pile production has made many more such medical projects practical.

Because of the extensive experimentation in this country and abroad, in university centers and at the Oak Ridge Institute of Nuclear Studies, it is not necessary to conduct experimental application of isotopes on patients in small general hospitals. There should, however, be a practical application at the community hospital level to improve accuracy of diagnosis and effectiveness of treatment.

Some of the agents and their uses now include radioactive iodine (I^{131}) for the diagnosis and therapy of certain thyroid disorders and for some euthyroid cardiac patients; radioactive phosphorus (P^{32}) for therapy of primary polycythemia vera; radioactive colloidal gold (Au^{198}) or colloidal chromic phosphate (P^{32}) for palliation of cancer in body cavities and certain prostatic and uterine neoplasms; radioactive iron, chromium, and iodinated human serum albumin for evaluation of red-cell mass, plasma volume, cardiac output, detection of lesions in brain and liver, and other diagnostic studies;

radioactive strontium (Sr^{90}) and cobalt (Co^{60}) as substitutes for radium and radon sources.

The broadest application of the isotopes listed is that of I^{131}, and it is with this that the author is chiefly concerned. Selection of other isotopes varies with hospital needs and individual talents and the background training of staff members.

The initiation of a program requires careful attention to radiation hazards. This involves proper care in the storage and supervision of use and disposal of all material according to well established physical facts and policies. Concern as to the possible carcinogenic effect of I^{131} appears to be unfounded. After fifteen years of usage no cause and effect relation has been observed.

One table. FRANK T. MORAN, M.D.
Auburn, N. Y.

Results of Radiation Resection or Elimination of the Thyroid Gland with Radioactive Iodine. W. Horst and E. Gadermann. Strahlentherapie **97**: 87–93, May 1955. (In German)

Surgical removal of the thyroid gland results in improvement of cardiac disorders in 66 per cent of all cases. Unfortunately, the surgical mortality is as high as 10 per cent. Thyroid function can also be partly or totally eliminated by treatment with radioactive iodine which is much less harmful than an operation.

It has been found that by induction of a hypothyroid condition the circulatory burden is alleviated and there is apparently an increase of coronary reserve. The authors have given radioactive iodine only in advanced cardiac disorders. Their technic of application is as follows: 20,000 rep per gram of thyroid tissue are given twice, with a lapse of one to two weeks between the two doses. If thyroid function fails to regress, the same series may be repeated at intervals of two months until the desired hypothyroid condition is obtained. When thyroid function is totally suppressed, substitution therapy with thyroid medication may become advisable. In some cases, however, total elimination of thyroid activity, with resulting myxedema, is necessary for favorable results. The usual cardiac regime is continued independently.

This procedure was used in 19 cases, with a favorable response in 13 and no response in 6. Especially suitable are cases with "dry" cardiac insufficiency and with advanced "stenocardia." The question whether or not life expectancy can be materially increased with radioiodine therapy cannot be decided for another five to ten years.

Three tables. ERNEST KRAFT, M.D.
Newington, Conn.

The Thyroidal Uptake of Radioactive Iodine as Modified by an Iodine-Restricted Diet. George A. Bishopric, Norman H. Garrett, and William M. Nicholson. J. Clin. Endocrinol. & Metab. **15**: 592–597, May 1955.

High thyroidal uptake of I^{131} in the absence of hyperthyroidism has been noted by various investigators. Many patients on the Kempner rice regimen at Duke Hospital showed a high thyroidal uptake of I^{131}, although there was no clinical or laboratory evidence of thyrotoxicosis. This avidity of the thyroid gland for iodine appeared to develop after a prolonged period on the diet, and was not observed in patients who had been on the rice regimen for three months or less. Of 12 patients on the diet for two years or longer, 9 (75 per cent) had uptakes of 46 per cent or more.

On the "basic" rice diet (rice, fruit, sugar, and honey) approximately 8 to 10 micrograms of iodine are ingested per day; the "modified" diet (with small additions of meat and vegetables) supplies 20 to 25 micrograms per day. The minimum daily requirement of iodine has been variously estimated from 15 to 40 micrograms daily. The ability of the body to store iodine probably accounts for the delay in the elevation of the thyroidal uptake of I^{131}.

No evidence of nutritional deficiency was observed in any patients, and in none of the 20 patients did thyroid enlargement develop while they were on the rice diet.

One figure; 1 table. G. W. REIMER, M.D.
Palo Alto, Calif.

Anionic Resin Measurement of Protein-Bound I^{131} in Euthyroid Children. W. A. Reilly, K. G. Scott, Robert W. Winters, and Harold L. Helwig. Am. J. Dis. Child. **89**: 572–574, May 1955.

The authors have previously described their technic for the determination of protein-bound iodine in plasma by anionic resin adsorption (Metabolism **3**: 506, 1954). It consists simply in treating plasma with anionic resin, separating by centrifugation, and crystal-counting the resin and supernatant plasma separately. The earlier study was done on adults. The present observations were made on 14 children who had previously been evaluated as euthyroid by history, physical examination, normal I^{131} uptake, blood protein-bound iodine, and serum cholesterol values.

This method indicates (1) the rate of protein binding, (2) the rate of its release from the thyroid, and (3) the blood level attained. The data are reported as counts per second per cent, and the results are compared with those obtained in adults. It was found that the children bound more iodine in a shorter time than adults. The authors feel that this test is quick, easy, and reliable.

One table. SUE L. NICKEY, M.D.
University of Texas, Dallas

Radioiodine Uptake in Thyroid Carcinomata. R. M. Cunningham, Gwen Hilton, and E. E. Pochin. Brit. J. Radiol. **28**: 252–256, May 1955.

The authors call attention to the need for criteria of the response of thyroid carcinoma to successive doses of radioiodine so that the size of the doses and the interval between them may be planned in such a way that, if possible, all the iodine-concentrating tissue will be progressively destroyed. Two factors enter into this problem: the degree of concentration of the isotope by the tumor and the sensitivity of the latter to the selective radiation that it receives in consequence. The present paper is concerned with the first of these, though it is to be kept in mind that this constitutes only half the requirement.

The study reported is based on 30 cases of histologically proved thyroid carcinoma. In 13 of these, and probably in 9 others, radioiodine was demonstrable in the tumor tissue, but in only 6 of these was this true before the surgical or radioiodine destruction of the normal gland, indicating that a useful degree of radioiodine uptake may be apparent after thyroid ablation in four times as many patients as when normal thyroid tissue is still present.

After removal of the thyroid, a tumor or its metastases generally show a brisk uptake of radioiodine.

In one of the cases studied in this series a large cranial metastasis was measured for such uptake at half-hour intervals after an intravenous dose of the isotope, and the accumulation rate was calculated. At the same time plasma samples were studied. In this way it was estimated that the metastasis has an iodine-concentrating efficiency about 10 per cent of that of normal thyroid tissue. Each gram of tumor was clearing hourly about 5 ml. of plasma of its contained iodine.

In cases in which the normal thyroid gland has been ablated, radioiodine is being removed from the circulation only by the normal kidneys, clearing 2,000 ml. of plasma per hour, and by the tumor which, according to the preceding observation, clears hourly 5 ml. of plasma per gram. On this basis, it can be calculated that the tumor dose per gram is somewhat less than 0.25 per cent of the therapeutic dose. This is in conformity with biopsy observations.

To investigate this point further, as well as the time during which the radioiodine is retained in the gland, the authors used a special scanning gamma counting device by which uptake and discharge of radioiodine could be followed from day to day. Carcinomas had a considerably heightened radioiodine turnover—about eight times as rapid as that of normal thyroid tissue. In the same patient metastases usually all showed equal rates of iodine turnover. Thyrotropin given twenty-four hours before the dose induced radioiodine uptake but did not change the discharge rate.

It has been shown in animals that the radioiodine passes from thyroid cells into the follicular colloid within a few hours and may be retained there for much longer periods. Reasoning from this, the authors believe that the rapid discharge of radioiodine in cancer is due to lack of organization and the consequent inadequacy of the follicular arrangement for retention of the isotope.

When the method of profile counting shows a relative decrease in uptake of radioiodine with successive doses, it would appear to indicate that the tumor is getting smaller. The same effect may in some cases be due to decrease in ability of the tumor to accept the isotope, despite continued growth.

An additional test suggested by the authors involves determination of the rate of thyroxine synthesis. The maximum protein-bound iodine concentration is reflected in the speed with which protein-bound radioiodine appears in the plasma after a dose of radioiodine, and in the maximum protein-bound radioiodine concentration (m.p.r.c.) which is reached in the week following such a dose. This is proportional to the total tumor uptake after successive doses.

Four figures.

WILLIAM SNOW, M.D.
Shreveport, La.

Thyroid Function in Disorders of the Hepatic Parenchyma. B. R. Scazziga, L. L. Barbieri, and T. Béraud. Schweiz. med. Wchnschr. **85:** 471–477, May 14, 1955. (In French)

The liver plays an important role in the catabolism and excretion of thyroxine. If there is an increased amount of circulating thyroxine, thyroid function is depressed. In the present study the basal metabolic rate, the serum protein-bound iodine, the radioiodine uptake, and conversion ratios were determined in 19 patients with epidemic hepatitis, 10 with alcoholic cirrhosis, and 4 with primary or metastatic carcinoma of the liver. In the patients with epidemic hepatitis, the serum protein-bound iodine levels were high compared to normal values; radioiodine uptake and conversion levels, on the other hand, were low. The patients with cirrhosis did not show significant changes. In 2 cases of extensive metastatic carcinoma, changes similar to those associated with hepatitis were noted, while in 2 with primary carcinoma normal values were obtained. Thus the retention of thyroxine and depression of thyroid function appear to parallel the degree of hepatic destruction or functional loss.

[For another discussion of the thyroid uptake of radioiodine in patients with impaired liver function, see Mueller *et al.*, J. Clin. Endocrinol & Metab. **14:** 1287, 1954. Abst. in Radiology **65:** 485, 1955.—Ed.]

Three diagrams; 5 tables.

CHARLES M. NICE, JR., M.D.
University of Minnesota

The Radioactive (I^{131}-Tagged) Rose Bengal Uptake-Excretion Test for Liver Function Using External Gamma-Ray Scintillation Counting Techniques. George V. Taplin, Orsell M. Meredith, Jr., and Harold Kade, with the technical assistance of Patricia Peel and Rhoda Devick. J. Lab. & Clin. Med. **45:** 665–678, May 1955.

The dye, rose bengal, has been used for many years to test liver function. The chemical structure of its molecule (the potassium salt of tetra-iodo-tetra-chlor-fluorescene) permits replacement of the stable iodine atoms with radioactive iodine (I^{131}) atoms which emit gamma rays. Following intravenous injection, the radioactive dye uptake may be detected over the liver area externally with scintillation counting equipment and technics similar to those employed for the radioiodine uptake test for thyroid function.

The radioactive rose bengal test described by the authors has a number of advantages over many other methods of testing liver function. First, it measures polygonal cell function directly rather than by change occurring in the blood (thereby eliminating repeated venipunctures); second, it registers graphically the rate of dye uptake and the time necessary for its excretion from the liver; third, it is the only dye test which can be used safely in the presence of biliary tract obstruction because of the minute quantities and low toxicity of the dye employed; fourth, it gives information concerning liver circulation as well as patency of the biliary tract; fifth, it appears to be many times more sensitive than non-radioactive dye tests.

Preliminary clinical results demonstrate that patients with some of the common diseases of the liver have fairly typical uptake-excretion patterns which are readily distinguishable from those recorded in normal individuals.

Need for additional clinical investigation is stressed, and some possible advantages from further modifications in technical procedures are suggested.

Four figures; 4 tables.

Pathological Study of Eight Patients with Glioblastoma Multiforme Treated by Neutron-Capture Therapy Using Boron 10. John T. Godwin, Lee E. Farr, William H. Sweet, and James S. Robertson. Cancer **8:** 601–615, May–June 1955.

The pathological findings in 8 cases of glioblastoma multiforme treated by thermal-neutron capture using boron-10 are presented. The rationale for this form of therapy lies in the greater differential uptake of boron by the neoplastic cells and the increment in capture

cross section of boron for slow neutrons, which is approximately 1000 times larger than the collision cross section of hydrogen for fast neutrons, which have been previously used. Although the slow neutrons have a very small energy (a fraction of an electron volt up to one electron volt), the disintegration products have high energies which are released in very short distances to produce intense local irradiation. The boron-thermal-neutron reaction, then, should be an efficient means of selectively irradiating neoplastic tissue, avoiding some of the undesirable features of more conventional forms of therapy.

The technic of treatment consisted in the intravenous administration of 20–25 milligrams of boron-10 in glycerine per kilo of body weight followed by thermal-neutron exposure from a nuclear reactor through a 2 × 4-inch port centered over the tumor mass. Since there is no satisfactory method of measuring the radiation dose, the total thermal-neutron exposure per square centimeter of skin is given.

The results were inconclusive, but changes within the tumor masses in 3 of the cases treated were suggestive of radiation effect. The greatest difficulty was in differentiating the changes associated with spontaneous degeneration commonly seen in glioblastoma multiforme from those which might have been effected by the treatment.

Twenty-seven figures; 2 tables.

ROBERT B. CONNOR, M.D.
University of Texas, Dallas

The Disposal of Radioactive Potassium Injected Intravenously. D. A. K. Black, H. E. F. Davies, and E. W. Emery. Lancet **1**: 1097–1099, May 28, 1955.

The authors describe an investigation of the disposal of radioactive potassium (K^{42}) injected intravenously. Their findings strongly suggest that the exchange of K between plasma and tissues takes place so rapidly that the K of arterial plasma is largely, if not wholly, superseded in venous plasma by K derived from the tissue during transit. If this is correct, certain consequences follow. A tracer dose of K^{42} given intravenously is almost at once distributed among the organs of the body in proportion to their relative blood supply. This initial disposal of injected K^{42} is followed without pause by its redistribution, with the end-result that the various organs contain K^{42} in proportion to their potassium content. The speed with which the specific activity in each organ approaches the final equilibrium value (or, more strictly, the specific activity in current arterial plasma) will be directly proportional to the blood flow through it and inversely proportional to its K content. Since the K in the venous drainage from a tissue is derived from the K content of the tissue, the specific activity of the mixed venous blood can be raised (or lowered) by altering the circulation, so that organs which at the time contain K of high (or low) specific activity make a greater contribution to the total venous flow.

Even if this theoretically derived pattern of K distribution is only partially correct (and some organs, such as brain, are exceptional in their behavior), the authors' actual results show that tissue and plasma specific activity can be greatly influenced by blood flow. This makes it unlikely that observations on the amount of K^{42} in plasma or in individual organs can give any definite information on alterations in the rate of exchange of K across the cell membrane during the phase of initial disposal and subsequent redistribution. This type of approach is therefore unlikely to yield useful conclusions on the state of the potassium household.

It seems likely that this pattern of distribution is characteristic not of potassium as such but of any substance which leaves the blood stream rapidly in relation to circulatory transit time.

Four figures.

Treatment of Peritoneal Mesothelioma with Radioactive Colloidal Gold. Report of a Case. Raymond G. Rose, John D. Palmer, and Marvin N. Lougheed. Cancer **8**: 478–481, May–June 1955.

The authors report the case of a 66-year-old white male with diffuse peritoneal mesothelioma treated with radioactive colloidal gold (Au^{198}). Prior to treatment with radiogold, some 250 paracenteses had been done over a period of eight years, with removal of 8,000 to 10,000 c.c. of fluid each time. The patient was given initially 100 mc of Au^{198} intraperitoneally followed by three instillations over the next five months, for a total of 364 mc. This resulted in a marked drop in the formation of peritoneal fluid. Over a two-year period following therapy, paracentesis was not necessary for the last eighteen months. The plasma proteins rose from 3.8 to 6.75, and free mesothelial cells, which were abundant in the ascitic fluid prior to Au^{198} therapy, disappeared.

The changes leading to a suppression of fluid formation appeared to be a combination of (1) a lethal effect on free cancer cells in the cavity; (2) the destruction of small tumor seedings, or destruction of the superficial cells of large tumor nodules and encasement in fibrous tissue; (3) the development of submesothelial fibrosis of the serosal surface; (4) radiation obliterative endarteritis of the small blood vessels supplying the serosa.

Five photomicrographs; 1 table.

B. J. PARNELL, M.D.
University of Texas, Dallas

Effects in Dogs of Large Doses of Intraperitoneally Administered Radioactive Colloidal Gold (Au^{198}). Andrew H. Jackson and P. F. Hahn. Cancer **8**: 482–487, May–June 1955.

Nine mongrel dogs were used in studying the effect of very large doses of Au^{198} injected intraperitoneally—from 11.8 to 42.9 mc. per kilogram of weight.

The animals receiving repeated injections showed the most marked gross changes. These consisted of anorexia, weight loss, and dehydration. The peritoneal cavities of 6 dogs contained serosanguineous or seropurulent fluid. In 5 there were firm, bluish-gray masses varying in size from 1 to 3 cm. in diameter. Sections of the peritoneum revealed extensive hyalinization with the accumulation of numerous cells laden with brownish-black pigment between this membrane and the underlying musculature. However, radiation ulcers and adhesions were not found in any of the dogs that exhibited peritoneal effusion.

There was moderate to extensive reticulum-cell hyperplasia in the abdominal lymph nodes, but the changes seemed to indicate a relatively poor gold uptake. Varying degrees of bone marrow hypoplasia and anemia were found in the animals receiving multiple injections, but an aplastic marrow was never observed.

Five photomicrographs; 1 table.

B. J. PARNELL, M.D.
University of Texas, Dallas

Tolerance of Bronchial Wall to High Level Dosage of Radioactive Colloidal Gold Following Intrabronchial Injection. Harold F. Berg, William M. Christophersen, and J. Ray Bryant. J. Thoracic Surg. **29:** 497–501, May 1955.

The authors in an earlier study demonstrated that when radioactive colloidal gold is injected into the submucosa of the bronchus of dogs, the colloidal sol is transported via the lymphatics from the site of injection to the regional lymph nodes, where it is trapped and concentrated (Bryant *et al.*: J. Thoracic Surg. **26:** 221, 1953. Abst. in Radiology **63:** 310, 1954). This earlier study was conducted with low-level dosage. The present investigation concerns the tolerance of the bronchial wall for doses of sufficient magnitude conceivably to have a therapeutic effect on bronchogenic carcinoma.

With a long (45 cm.) needle, the intermediate bronchus of each of nine dogs was injected, via the bronchoscope, with doses of colloidal Au^{198} ranging from 30 to 100 mc. All animals survived and appeared to be in a normal state of health at the time of autopsy, from twenty-one to sixty-six days after injection.

Histologic examination of the site of injection, regional lymph nodes, lungs, liver, spleen, kidneys, and bone marrow was made. Evidence of radiation effect was confined to the injection site and its lymph drainage area. Technical errors in injection resulted in pericarditis and mediastinitis in one animal and radiation necrosis in the lower lobe of the right lung in another. There were no untoward effects at the site of injection, indicating that mobilization from the mucosa to the nodes takes place rapidly, before severe local injury results. Radiation effect of varying degree was present in the lymph nodes of all animals.

One photograph; 4 photomicrographs.

A. I. BALMER, M.D.
St. Paul, Minn.

Influence of Chelates on the Metabolism of Radioyttrium (Y-90). H. C. Dudley. J. Lab. & Clin. Med. **45:** 792–799, May 1955.

A study by the author of the influence of various chelating agents on the metabolism of yttrium (as Y^{90}; half-life sixty-one hours; 2.2 Mev beta emissions) showed that by selection of the proper reagent one may promote preferential deposition in selected tissues within forty-eight hours. The chelating agents used in the investigation were: citrate; ethylenediamine tetra-acetic acid (EDTA); N'hydroxy ethylenediamine triacetic acid (ED-ol); N,N'-dihydroxy ethylenediamine diacetic acid (ED-diol); N,N'-dihydroxy-ethylglycine (EG-diol); and nitrilo triacetic acid (NTA).

Yttrium in a complex with citrate, ED-diol, or NTA was deposited in the liver, spleen, and bone marrow of rabbits. When there was an excess of EDTA, ED-diol, or ED-ol, the yttrium was preferentially deposited in bone, with ED-ol giving the highest bone-soft tissue ratios.

Yttrium in a complex with a minimum quantity of ED-ol was markedly concentrated in the wall of the stomach.

Radioyttrium (Y^{90}), administered intravenously as the chelate, is suggested as a means of delivering ionizing radiation of high energy to selected tissues, particularly to bone and stomach.

Three tables.

A Comparison of Routine Plasma Volume Determination Methods Using Radioiodinated Human Serum Albumin and Evans Blue Dye (T-1824). Robert E. Zipf, Joe M. Webber, and G. Richard Grove. J. Lab. & Clin. Med. **45:** 800–805, May 1955.

The authors carried out 34 simultaneous plasma volume determinations with radioiodinated human serum albumin (RISA) and Evans blue dye (T-1824) on 33 different subjects to compare the relative accuracy of the two methods. The T-1824 method showed an average probable error of precision of 213 ml., or 5.2 per cent, while the RISA gravimetric method yielded an average probable error of 59 ml., or 2.3 per cent. This difference in probable error is presumed to be due to the differences in accuracy inherent in volumetric and gravimetric measurements, and not to any intrinsic difference in the biochemical or physiologic characteristics of the two substances. RISA is readily adaptable to the gravimetric technic, while the currently available preparations of Evans blue dye must be used volumetrically throughout the procedure. The authors feel that, because of its superiority, the isotope method should replace the T-1824 method as a standard procedure for blood and plasma volume determination.

The Tagging of Leukemic Leukocytes with Radioactive Chromium and Measurement of the In Vivo Cell Survival. Mary Sue McCall, Donald A. Sutherland, Anna M. Eisentraut, and Henry Lanz. J. Lab. & Clin. Med. **45:** 717–724, May 1955.

The authors describe an *in vitro* method for tagging leukemic human granulocytes, lymphocytes, and their precursors with radioactive sodium chromate ($Na_2Cr^{51}O_2$). The exact mechanism of the tagging process remains unknown, but was influenced by varying the temperature of incubation. In 4 instances, such *in vitro*-tagged leukocytes were found to circulate *in vivo* following autotransfusion for at least twenty-four hours. Although the majority of the cells were rapidly removed from the circulation, in 2 patients the Cr^{51} activity in the leukocytic fraction was followed and small numbers of tagged leukocytes persisted in the circulation for five days.

Leukemic leukocytes were tagged *in vivo* by an intravenous injection of radioactive sodium chromate. The leukocytes in chronic myelogenous leukemia had a measured intravascular life span of approximately thirteen days. A similar decay curve was observed in 2 cases of chronic lymphatic leukemia but the cells from 2 other patients with chronic lymphatic leukemia showed a prolonged survival, with a mean life span of approximately thirty days. The cells in 1 case of acute lymphatic leukemia had a life span of ten days.

Two charts; 1 table.

Uses and Limitations of Survival Studies of Erythrocytes Tagged with Cr^{51}. Max M. Strumia, Lawrence Taylor, Albert B. Sample, Louise S. Colwell, and Ann Dugan. Blood **10:** 429–440, May 1955.

The purpose of this paper is to point out certain limitations in the application of survival studies of erythrocytes tagged with Cr^{51} to the investigation of hemolytic phenomena *in vivo*. The discussion is directed primarily toward the method of survival studies and its validity rather than to the survival of erythrocytes *per se*. For the procedures, which are complex and presented in some detail with applicable formulae, one must consult the original article.

The authors express the belief that autotransfusion of Cr^{51} tagged red cells in a normal individual or transfusion of tagged cells from a normal donor to a compatible normal recipient provides a valid method for measurement of the post-transfusion survival of the red cells. The use of Cr^{51} tagged cells is also advantageous in determining the effect of various factors in the collection and storage of blood used for transfusion.

Transfusion of tagged cells from a patient suspected of having an abnormality of the red cells which affects their life span, into a normal recipient, is a satisfactory method for determining any such abnormality.

When autotransfusion of tagged cells is used to determine the life span of the cells in a patient suffering from hemolytic phenomena, corrections of obtained values must be made according to the variations in the red cell volume caused by the rate of new red cell production. Determinations of the volume of the red cell mass at the beginning and end of the observation, with frequent determinations of the hematocrit in the intervening days, is a method by which such correction may be made.

The hemolytic index is generally in fair accord with results of Cr^{51} survival studies corrected for variations in the red cell mass.

Six graphs. PAUL W. MATHEWS, JR., M.D.
University of Texas, Dallas

RADIATION EFFECTS

Studies of the Metabolism of Radium in Man. William P. Norris, Thomas W. Speckman, and Philip F. Gustafson. Am. J. Roentgenol. **73:** 785–802, May 1955.

In 1931 a selected group of patients in Elgin State Hospital (Illinois), mostly with dementia praecox, were given multiple intravenous injections of radium chloride. The dosage was recorded and the patients were measured for radium retention on two separate occasions within the first year. Nineteen of the original 32 patients were located in 1951 and studied for clinical symptoms and for radium content. This report deals with the physical determinations and attempts to draw conclusions concerning long-term metabolism of radium in man.

The concept of a well defined biological half-time in bone is inconsistent with the long-time data presented. Previously published information has shown that retention and excretion of radium in animals may be represented as "power functions" (which plot as straight lines on log paper). The authors have demonstrated that where persons are exposed to soluble radium salts at a more or less constant level over a period of time, the application of the power function may be extended to predict radium burdens with time or to estimate the retention pattern following cessation of exposure.

The retention of radium in the patients studied was 0.6 per cent of the original dose after twenty-two years.

One photograph; 4 graphs; 7 tables.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

The Evaluation of Irradiation Damage to the Skin as Determined by Measuring the Capillary Resistance. T. Szenes. Fortschr. a. d. Geb. d. Röntgenstrahlen **82:** 614–618, May 1955. (In German)

The histological and pathological changes following the irradiation of the skin with 1,000 r or more are described. An inflammatory reaction, with dilatation of the vessels, is followed by a round-cell infiltration of the vessel walls. Later there is edema of the connective tissue causing compression of the vessels and proliferation of the intima. After the fifth week, the inflammatory changes gradually subside and a fibrous transformation, with thickening of the vessel wall and stenosis of the capillaries, ensues. Then, due to perivascular fibrosis, many of the capillaries are obliterated.

The author, anxious to study the x-ray damage in the skin clinically, thought it could best be done by determining the capillary resistance according to the method of Borbely (München med. Wchnschr. **1:** 886, 1930). A suction cup measuring 2 cm. in diameter is placed on the skin, and negative pressure is applied until, within one minute, three to four petechiae appear. The pressure is measured in centimeters of mercury. As the vessels become fibrotic under the influence of irradiation, the pressure has to be increased to produce petechiae.

At first the author examined 35 patients who, following amputation of the breast, had received within twenty to twenty-five days ten x-ray treatments of 200 r each (180 kv, 0.5 mm. copper, 6 ma., 50 cm. distance, field size 10 × 15 cm.). Tests were made every few days over the healthy breast as well as over the irradiated chest wall for a period of over two hundred days. The results were remarkably similar in all cases. While over the healthy breast a fairly steady negative pressure of between 10 and 20 cm. mercury was necessary to raise the petechiae, over the irradiated area the pressure had to be increased after the first few treatments. Within about three weeks it rose to over 50 cm. After about three months the pressure dropped gradually and by the two hundredth day it approached normal, indicating that the damage to the blood vessels was reparable and that almost normal conditions had been restored.

A single x-ray dose of 600 r produced a similar curve. When a single dose of 400 or 300 r was given, the curve was not as steep and approached the norm more rapidly. In one case which had received very extensive x-ray treatment resulting in marked telangiectases, return to normal did not occur; six to ten years after irradiation a negative pressure of over 50 cm. mercury was still necessary to produce the three petechiae, indicating permanent fibrosis of the vessels and damage to the skin.

From these measurements the author draws the conclusion that the determination of the capillary resistance is a direct measure of the damage done to the skin and a follow-up indicates the regeneration that occurs following irradiation. He feels that further studies are indicated and that the test may be of great value in determining when a plastic operation should be performed and when, or if, further irradiation can be applied. Histologic examination paralleling these capillary tests would be of great value.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Late Effects of Beta Radiation on the Eye. George R. Merriam, Jr. Arch. Ophth. **53:** 708–717, May 1955.

This paper is similar to one recently published in RADIOLOGY (**66:** 240, February 1956). It includes 10 illustrative case histories not contained in the latter article. The conclusions are the same.

Thirteen photographs; 2 tables.

Ocular Effects Produced by High-Intensity X-Radiation. Paul A. Cibis, Werner K. Noell, and Bertram Eichel. Arch. Ophth. **53:** 651–663, May 1955.

The effect of high-intensity ionizing radiations upon the eye in four species of mammals is reported. The animals subjected to radiation were 15 guinea-pigs, 162 rabbits, 2 Rhesus monkeys, and 2 dogs. Adequate numbers of controls were employed. The head or single eye of the animal was exposed to radiation of 260 kvp. and 18 ma. The total dose administered ranged from 1,700 up to 35,000 r. The major clinical and histological results are summarized as follows:

(1) The functional and histological patterns developing after high-intensity x-irradiation of the eye are fairly consistent and reproducible. (2) High-intensity x-irradiation causes vascular and/or cytological response in all ocular tissues with the exception of the sclera. (3) The most significant change in the eye of adult mammals following high-intensity irradiation is the death of the rod cell population. This becomes functionally noticeable within ten minutes by changes in the ERG [electroretinogram], loss of the pupillary reflex to light, night blindness in monkeys and dogs, and complete blindness in rabbits and guinea pigs. (4) The latent period for the microscopic appearance of rod cell death is about five to six hours. (5) The minimum lethal dose of x-radiation for rod cells, under the conditions of the experiments, lies between 1,700 and 2,000 r. (6) The minimum lethal dose of x-radiation for cone cells is probably greater than 10,000 r and less than 30,000 r. (7) The deleterious effect of high-intensity x-radiation upon the rod cell population is followed by secondary degenerative changes affecting the cone cells in the periphery of the retina of monkeys and dogs. (8) These latter changes must gradually result in extreme constriction of the visual field; those mentioned in (6), in immediate blindness of the exposed dog, monkey, or man. (9) Transient impairment of photopic vision and blindness, due to retinal edema, papilledema, and vascular disturbances in the eye and brain, can be expected to develop after a latent period of a few hours following exposure to high-intensity ionizing radiation.

Twenty-three photographs and photomicrographs.

The Quantitative Determination of Gamma-Ray Emitting Elements in Living Persons. L. D. Marinelli, C. E. Miller, P. F. Gustafson, and R. E. Rowland. Am. J. Roentgenol. **73:** 661–671, April 1955.

A sodium iodide scintillation counter apparatus has been used for the determination of the gamma-ray activity of radon retained in the bodies of individuals who ingested or inhaled radium twenty to thirty-five years previously. For greater sensitivity, the background radiation was reduced by means of 1/4-inch lead shielding and the signal-to-background ratio was improved by selection of the pulse energy band.

A method, based on Evan's technic (Am. J. Roentgenol. **57:** 368, 1937), has been evolved capable of reducing the average probable error to $\pm 6 \times 10^{-10}$ grams of radium activity in the human body with an observation period of two hours.

Confidence in the procedure has been established by control experiments with Na^{24} in human beings and Ra^{226} in dogs.

Four figures; 3 tables.

The Effects of Gamma and Roentgen Radiation on the Intact Spinal Cord of the Monkey. An Experimental Study. Robert L. McLaurin, Orville T. Bailey, Griffith R. Harsh, III, and Franc D. Ingraham. Am. J. Roentgenol. **73:** 827–835, May 1955.

An experiment conducted on the spinal cords of 35 *Macacus rhesus* monkeys was done to reassess the clinical and histopathological effects of radiation on nerve tissue, to attempt to establish the tolerance of neural tissue for intensive radiation by radioactive isotopes as a basis for future tumor therapeutic efforts, and to compare quantitatively and qualitatively gamma and roentgen radiation.

Eighteen monkeys were irradiated by radioactive tantalum placed extradurally in polyethylene tubing to shield its beta component. The gamma irradiation was carried out at intensities varying from 1.1 to 185 r per hour, with total doses at the center of the cord of 213 to 38,088 r. Roentgen radiation was given at 125 kv, with 1 mm. aluminum filter. Intensity was 138 r per minute at the center of the cord, with a range in roentgens per day from 1,320 to 8,500 r. Total doses varied from 4,000 to 22,500 r.

It was concluded that the clinical response to radiation was dependent more on the rate of administration than total dose. Thus, the limit of gamma radiation appears to be at an intensity of 135 r per hour, as in all animals treated at that rate or above some degree of paraplegia rapidly developed. This effect was delayed or failed to appear in less intensively irradiated animals. At the high intensity, total doses as low as 3,100 r produced paralysis, while with low dose rates a maximum of 38,088 r could be delivered without paralysis. With roentgen radiation, dosage rates of 3,000 r per day or over were necessary to produce paralysis. A single dose of 5,000 r was the maximum tolerated by most animals, while at a daily rate of 1,500 r per day a total dose of 15,000 to 22,000 r could be tolerated.

It appeared that demonstrable histologic changes depended on length of survival after irradiation and the total amount of radiation received, the first of these two factors being the more important. Early histologic changes were scanty even in animals with total paraplegia, suggesting to the authors that the results may be attributable to massive vasospasm. Later there were varying degrees of vascular alteration including necrosis of the arterial walls with subsequent occlusive endothelial proliferation. Both the white and gray matter also exhibited disruption and necrosis, with marked glial proliferation in the damaged areas of white matter.

The tolerance for 125 kv roentgen radiation was felt to be somewhat less than for gamma radiation. Histologic changes were qualitatively similar with the two types of radiation, but more severe with gamma radiation.

Three illustrations; 3 tables.

J. A. GUNN, M.D.
Grand Rapids, Mich

Effect of Total Body Irradiation on Experimental Renal Transplantation. Roger Baker and Robert Gordon. Surgery **37**: 820–822, May 1955.

Evidence to date supports the concept that failure of renal transplantation is the result of the development of antibodies by the host in response to the foreign protein of the graft. Since irradiation is known to affect the hematopoietic system and thereby decrease antibody formation, the authors sought to determine the effect of this procedure in animals receiving renal transplants.

Nine mongrel dogs were given single doses of total-body irradiation by the bilateral exposure technic (225 r, 2,000 kv). Kidneys from non-irradiated dogs, as well as from irradiated donors, were transplanted one to seven days following irradiation of the host. One dog died of irradiation sickness. The remaining 8 failed to show a significant increase in duration of function of the transplanted kidney as compared to a control series.

One photograph.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Effects of Roentgen Irradiation on the Tumor Bed. The Inhibiting Action of Local Pretransplantation Roentgen Irradiation (1,500 r_a) on the Growth of Mouse Mammary Carcinoma. K. W. Stenstrom, H. Vermund, D. G. Mosser, and J. F. Marvin. Radiation Res. **2**: 180–191, April 1955.

The authors describe an investigation of the effects of irradiation on the tumor bed.

Twenty mice of the inbred ZBC strain, six to ten weeks of age, were used in each of ten experiments. Ten animals were given local roentgen irradiation to the right leg; the 10 remaining animals served as controls and were treated identically except that they were not exposed to irradiation.

The animals were placed in a cylindrical protective device in such a way that the right hind leg was immobilized up to the groin within the primary x-ray beam while the rest of the animal was shielded. The x-ray dosage was 1,500 r in air with a half-value layer of 4.2 mm. aluminum. Measurements with a thimble ionization chamber showed that less than 0.2 per cent of the dose delivered to the leg inside the lead wall of the cylinder was scattered outside of the hole in the wall, indicating the effectiveness of the protection provided. Forty-eight hours after irradiation a suspension of tumor cells from a spontaneous mammary carcinoma was injected subcutaneously on the dorsal aspect of each hind leg. Both the irradiated and non-irradiated control animals were injected at identical sites from the same tumor cell suspension. At weekly intervals, or oftener, each animal was examined for presence of palpable tumors.

The tumor transplants in the irradiated leg showed a definite inhibition of growth in all experiments. Frequently, a delay in the onset of tumor growth was observed, so that a low incidence was recorded at the earlier intervals. During the following weeks, small, firm nodules could be palpated on the irradiated side in a greater number of mice. In the third week 16 of a total of 97 animals (16.5 per cent) had palpable tumors on the irradiated leg; in the sixth week 34 of 55 surviving animals (62 per cent) had palpable tumors. The corresponding figures for the unirradiated legs in the same animals were 94 per cent and 100 per cent as compared with 94 per cent and 98 per cent for the control animals. A growth-inhibiting influence by pre-irradiation of the tumor bed was further manifested by the small size of the tumors which finally developed in the irradiated tissues.

Quantitative differences in response were shown between different tumor lines of the same type of mammary carcinoma.

Since the tumor tissue itself received no irradiation, the inhibition must be attributed to radiation effects on the tumor bed or the normal tissues in which the tumor grows.

Four figures; 2 tables.

Biological Modification of Effects of Roentgen Rays. II. High Temperature and Related Factors. Frederick M. Allen. Am. J. Roentgenol. **73**: 836–848, May 1955.

The author summarizes the results of a series of well planned, carefully performed experiments upon rats with experimental Crocker sarcoma No. 39. These experiments are concerned mainly with efforts to modify the biological effects of roentgen rays by means of high temperature and related factors. Some very interesting observations and conclusions are reported. Some of each will be recorded here.

1. The effects of total-body irradiation are quickly manifested, while the effects of local irradiation are not evident for about two weeks.

2. A considerably higher amount of total irradiation is tolerated if given in divided doses than when administered in a single dose, whether locally or to the entire body.

3. The rat sarcoma withstands higher single doses than are ever given to tumors in man; hence it is well suited for therapeutic trials.

4. The latent period following irradiation of the tumor is short, and tumor recession is completed some time during the latent period of the normal tissues.

5. The author stresses the fact that observations previously made, when factors augmenting radiation effect were studied, have not specified whether the effects have been predominantly on the tumor or upon the normal tissues. The reports have been concerned mainly with the primary erythema, whereas, late degeneration is the limiting factor in modern irradiation therapy.

6. Therapeutic induction of fever gave inconclusive results and application of local heat with simultaneous use of irradiation therapy failed to permit very decisive conclusions.

7. Ultrasound, when used to generate local heat, produced results which gave a clue to further procedures in line with earlier ligation experiences.

8. Inflammation by dry oven heat rendered rat-tail tumors curable by moderate roentgen-ray dosage. Small superficial leg tumors were curable by the same agent or infra red rays in combination with moderate roentgen dosage.

9. Rat-tail tumors were capable of being cured by heat alone. Microwave diathermy with skin refrigeration and roentgen therapy within safe limits controlled large leg tumors. These forms of energy may be synergistic.

10. The author suggests that heat is a superior lethal agent for tumors because (*a*) it can destroy all tumors, even radioresistant ones; (*b*) tumors do not develop resistance to heat; (*c*) if burns are avoided, there are no cumulative or degenerative effects.

It is suggested that apparatus be developed which will enable the radiation therapist to utilize the therapeutic possibilities suggested by these studies.

H. C. JONES, M.D.
Grand Rapids, Mich.

Hematologic Changes in Rats Protected from Lethal X-Radiation by Post-Irradiation Parabiosis. George Metz, Robert T. Binhammer, Martin Schneider, and John C. Finerty. Radiation Res. **2:** 159–165, April 1955.

The authors describe an investigation of the hematologic aspects of post-irradiation parabiosis in an attempt to elucidate the role of circulating blood in protection from radiation injury.

Female littermate rats, weighing 115 to 125 gm., were divided into four groups: Group I, parabionts, one partner of which was irradiated with 700 r (LD 98/30) three hours prior to surgical union; Group II, single animals irradiated with 700 r; Group III, non-irradiated parabionts; Group IV, single non-irradiated animals.

There was an abrupt decrease in the number of leukocytes of the irradiated animals on the second day after irradiation, with no distinction between the irradiated parabionts (Group I) and the single irradiated animals (Group II). In the single irradiated animals this decrease persisted until death on about the seventh day; in the irradiated parabionts a gradual recovery began on the fourth day and persisted until a normal range was reached by the eighth post-irradiation day. In the non-irradiated partners of Group I, leukocytosis occurred between the second and eighth days, with a peak at day four. After the eighth day both irradiated and non-irradiated partners followed a normal pattern.

In Group III, in which neither parabiont was irradiated, there was a slight increase in the number of leukocytes above that of the single control animals. The difference was small and probably not significant.

All irradiated animals showed a rapid decline in the absolute number of lymphocytes as well as a slight decrease in the number of heterophile leukocytes, resulting in a severe leukopenia. Some recovery of these two cell types was apparent by the sixth day in the irradiated partners of Group I, whereas there was no indication of peripheral recovery in the single irradiated animals. This finding may be of significance in parabiotic protection from the effects of irradiation.

No significant changes were observed in the red cell counts.

Three graphs.

The Effect of Fractionated X-Ray Dosage on the Frequency of Chromatid and Chromosome Aberrations. Karl Sax, Edward D. King, and Henry Luippold. Radiation Res. **2:** 171–179, April 1955.

The experiments reported were designed to compare the effects of fractionated dosage on chromatid aberrations induced at prophase with the chromosome aberrations induced during the resting stage.

The frequency of two-hit chromatid aberrations induced at prophase and two-hit chromosome aberrations induced at the resting stage in *Tradescantia* microspore nuclei is reduced if the x-ray dose is fractionated. This reduction is attributed to the restitution of breaks during the rest periods between exposures. If these periods are sufficiently long, the frequency of the two-hit aberrations should be no greater than the frequency induced by a single exposure multiplied by the total number of exposures—the base line.

The two-hit chromatid aberration frequency approaches the base line with rest periods of five minutes, but for two-hit chromosome aberrations the frequency does not reach the base line until the rest periods between fractionated doses approach one hour. The more rapid decline in the frequency of chromatid aberrations after fractionated x-ray dosage is attributed to more rapid restitution of induced chromatid breaks caused by more active chromosome movements or greater metabolic activity of the prophase chromosomes as compared with the chromosomes during the resting stage.

The frequency of two-hit chromosome aberrations fell below the base line after fractionated x-ray exposures when the rest periods were increased to two hours, and it remained below the base line with rest periods of four and eight hours, respectively. There was no evidence of recovery during the longer rest periods.

The frequency of the two-hit chromatid aberrations did not fall significantly below the base line with rest periods up to one hour. The frequency of one-hit chromatid aberrations did not exceed that of the base line after a single-exposure total dose of x-rays but did fall slightly below the base line with fractionated doses with rest periods of five, fifteen, thirty, and sixty minutes, respectively.

Although there was some evidence of an injurious effect of irradiation, making the chromosomes less sensitive to the second and subsequent exposures in the fractionated dosage series, the major factor in the decline of x-ray-induced chromosomal aberrations after fractionated dosage can be attributed to the restitution of chromosome breaks during the rest periods.

Two graphs; 2 tables.

Response to Total Body Irradiation. Andrew H. Dowdy and Leslie R. Bennett. Am. J. Roentgenol. **73:** 639–648, April 1955.

Radiation Protection Problems in Diagnostic Roentgenology. George C. Henny. Am. J. Roentgenol. **73:** 649–654, April 1955.

Radiation Protection in Therapeutic Radiology. H. O. Wyckoff. Am. J. Roentgenol. **73:** 655–659, April 1955.

Dowdy opens a Symposium on Radiation Protection with a discussion of the total-body response to irradiation. This is a manifestation of chemical, cellular, and tissue changes, providing the sum total of these specific and individual alterations is of sufficient magnitude to be reflected in the clinical behavior of the irradiated animal. The type of response, its time of occurrence, its duration and degree depend upon the species of animal involved, the size of radiation dose given, the associated modifying circumstances, and the duration of the observation period.

Animals succumbing in the first three to five days following acute total-body irradiation usually do so as a result of extremely high dosages or unusual individual susceptibility. Little is known about the mechanism of death in such instances. The main contributing factors in the deaths occurring after the first few weeks following irradiation are hemorrhage and sepsis. The mechanism of hemorrhage and the origin and modes of infection are not yet completely understood.

Various prophylactic measures may be employed to prevent or circumvent many of the prompt total-body responses. Therapeutic measures applicable in the postirradiation period have been more difficult to evaluate and are slower in development. Distinct progress is being made and at least partial success seems likely.

The delayed total-body response is less well understood than the prompt response, and it seems probable that entirely different mechanisms are involved. There are no means at present for modifying or greatly reducing their frequency. Since personnel in departments of radiology are unlikely to receive sufficient exposure to produce acute radiation signs and symptoms, our primary concern is possible exposure to amounts in excess of the maximum permissible over long periods of time.

Henny states that the protection problems encountered in diagnostic roentgenology can be solved by attention to details of technic, by interposition of adequate protective barriers, and by increase of distance from the scattering object when possible. He also discusses the principles upon which changes of quality of the x-ray beam may be used to protect both the patient and roentgenologist.

In his paper on radiation protection in therapeutic radiology, Wyckoff takes up first the origins of the radiation and then indicates possible designs which will provide economical solutions to the protection problem. Careful consideration of both the expected work load in the forseeable future and possible restrictions in the orientation of the useful beam are regarded as the most fruitful field for reducing the cost of radiation protection.

Radiation Hazards in the Use of Thorium X for Skin Therapy. S. J. Wyard, A. Nightingale, and I. G. Austin. Brit. J. Radiol. **28:** 274–278, May 1955.

Thorium X is used widely in dermatological departments for a variety of skin conditions. The substance has a short half-life and emits radiation in the form of alpha particles, which have very little penetration in tissues. Because of these two factors, it has been used without the precautions customary with radioactive substances.

The authors made an extensive investigation to determine if there is any danger to the patient or to the persons administering the treatment. As used in the hospital where the study was made, Thorium X comes in bottles containing 1,000 e.s.u., which is a normal dose. This is painted in the skin. It was found that with reasonable precautions, such as keeping the bottles well stoppered and protecting the brushes when not in use, neither the patient nor the staff was receiving an excessive amount of radiation. If an unusually large number of patients must be treated, forced ventilation is an additional safeguard, as it relieves the concentration of thorium in the atmosphere.

Two graphs; 2 tables.

G. J. WOOLHANDLER, M.D.
Shreveport, La.

The Quantity of Radiation Received by the Reproductive Organs of Patients during Routine Diagnostic X-Ray Examinations. R. W. Stanford and J. Vance. Brit. J. Radiol. **28:** 266–273, May 1955.

Radiation can reach the reproductive organs either from the direct beam during investigations of the pelvic region or by scatter during examinations of other parts of the body. For males, measurements can be made directly by placing a suitable instrument in contact with the scrotum during the roentgen studies. The dose to the ovaries must be determined indirectly by measuring the amount received at a given point on the skin and using conversion factors based on the ratio of skin dose to ovary dose as obtained on the cadaver. The conversion factors for different examinations, as determined by the authors under different conditions of irradiation, are tabulated.

The authors have also tabulated radiation dose to male and female gonads *per film*, along with the exposure factors and the number of films per examination. Thus, for a straight view of the chest, for which a single film is required, the dose to the male gonads is 0.36 mr and to the ovaries 0.07 mr. With an anterior posterior view of the lumbosacral joint, the male gonads will receive 22 mr and the female gonads 220 mr; for a lateral view, the corresponding figures are 15 mr and 800 mr.

Because of concern for the genetic effects of irradiation, an analysis was made of the age group under thirty years and the average quantities of radiation received by the reproductive organs for various examinations are set forth.

The use of filters in the primary radiation beam causes a significant decrease in the skin dose but produces little effect on the quantity of radiation reaching either male or female gonads as a result of scatter. The authors' observations suggested also that less radiation need be delivered to the skin if the higher kilovoltage technics are employed. Actually, use of high kilovoltage screens may reduce the skin dose by 50 per cent, but the combined effect of the increased depth dose and reduced transmission by the 16:1 ratio grid may, it appears, result in a larger total dose at points within the patient. In particular for female patients, when the ovaries are more liable to be in the direct beam, the "gonad dose" at high kilovoltages may exceed that at low kilovoltages, while the increased scatter at high kilovoltages may lead to higher "gonad doses" for both male and female patients when the radiation is being received indirectly.

Careful control of the field area gives beneficial results, since it can prevent reproductive organs from receiving radiation directly. Reduction in field size also limits the volume of tissue irradiated, with a concomitant reduction in the amount of scattered radiation.

The authors made the tests at several hospitals and warn that the results vary somewhat under different working conditions. Nevertheless, the charts serve as a practical guide.

Eight tables; 1 figure.

WILLIAM SNOW, M.D.
Shreveport, La.

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